Protecting Aquatic Ecosystems by Understanding Watershed Processes

Schedule
9:00 am to 3:30 pm

- Intro to class
- Intro to guidance
- Overview of Steps & Appendices
- Example of a Watershed Characterization in Leavenworth
- Break
  - Group Discussion on Planning/Restoration Recommendations

Lunch Break

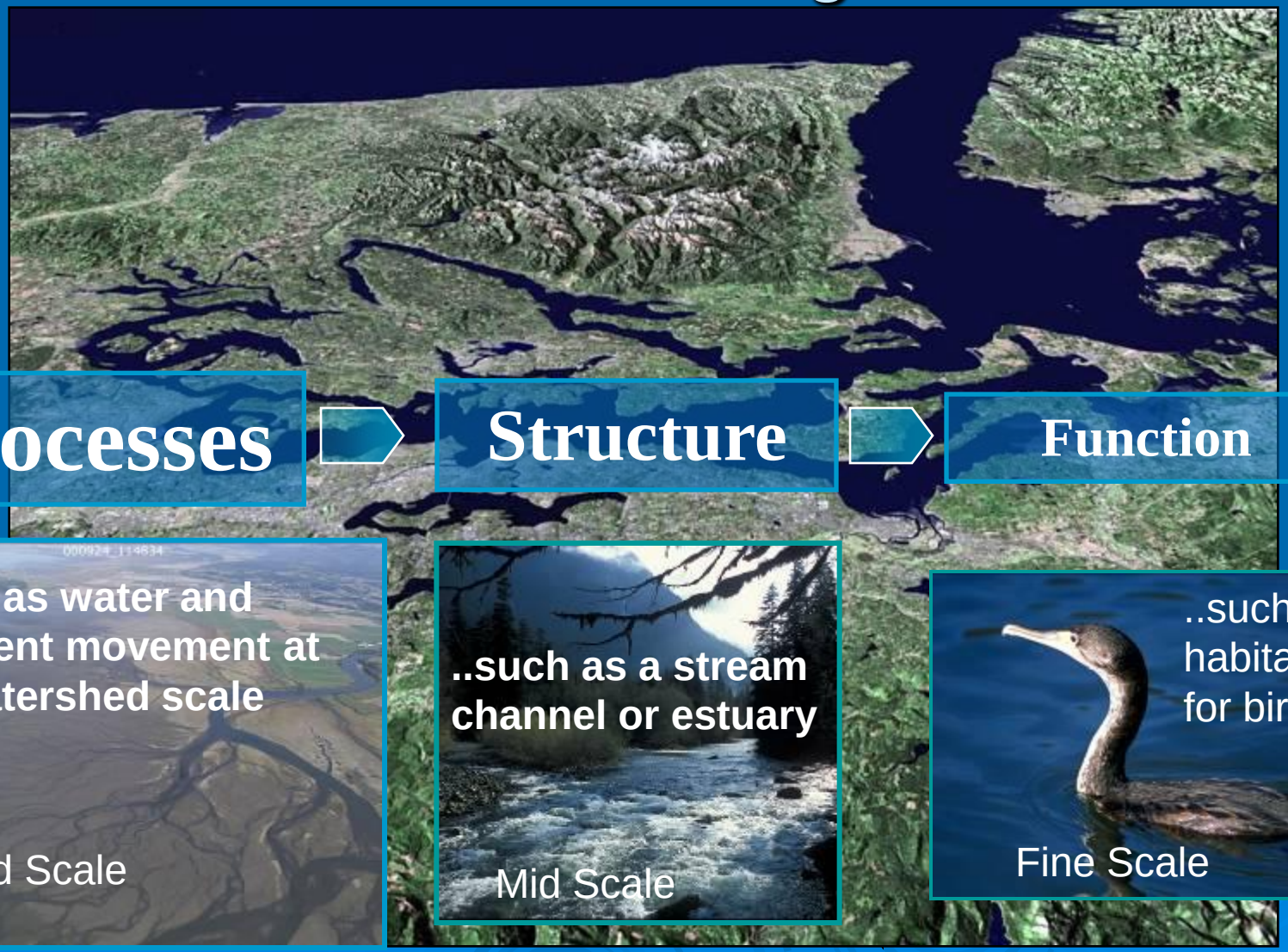
- Introduction to models for Water Flow Processes
- Example of using results to develop a Watershed Based Management Plan for:
  - Clark County
- Break
  - Birch Bay
- Application to Shoreline Planning & Permitting - Anacortes
- Summary and Wrap Up

Objectives of Class:

To Understand:

- Benefits of a watershed approach
- Role of watershed processes
  - Focus on water flow processes
- How to apply Ecology's Guidance
- How to apply the results of characterization to local planning

A Watershed or Ecosystem Approach to Planning



Processes → **Structure** → **Function**

..such as water and sediment movement at the watershed scale

Broad Scale

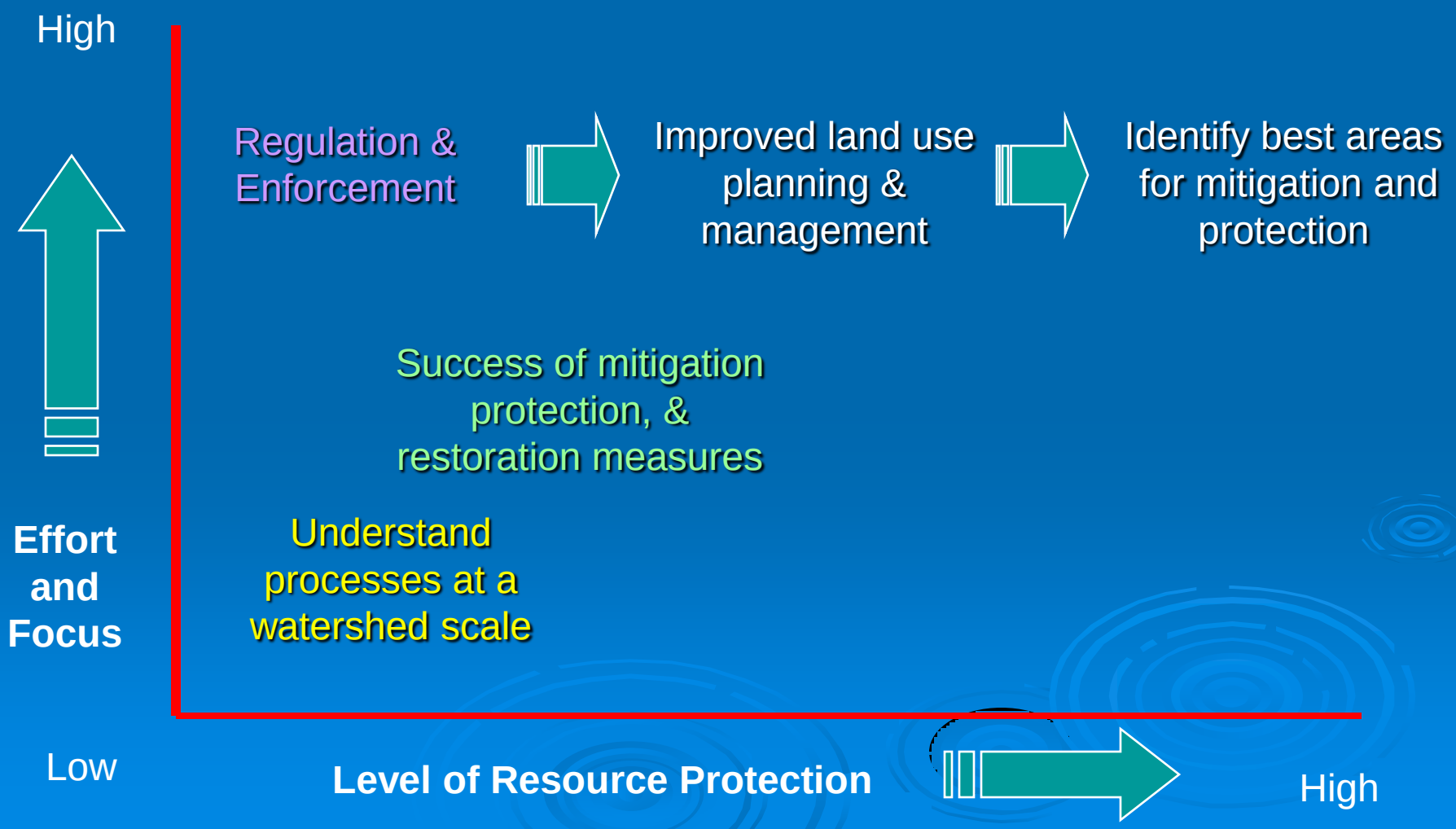
..such as a stream channel or estuary

Mid Scale

..such as habitat for birds

Fine Scale

Benefits of a Watershed Approach

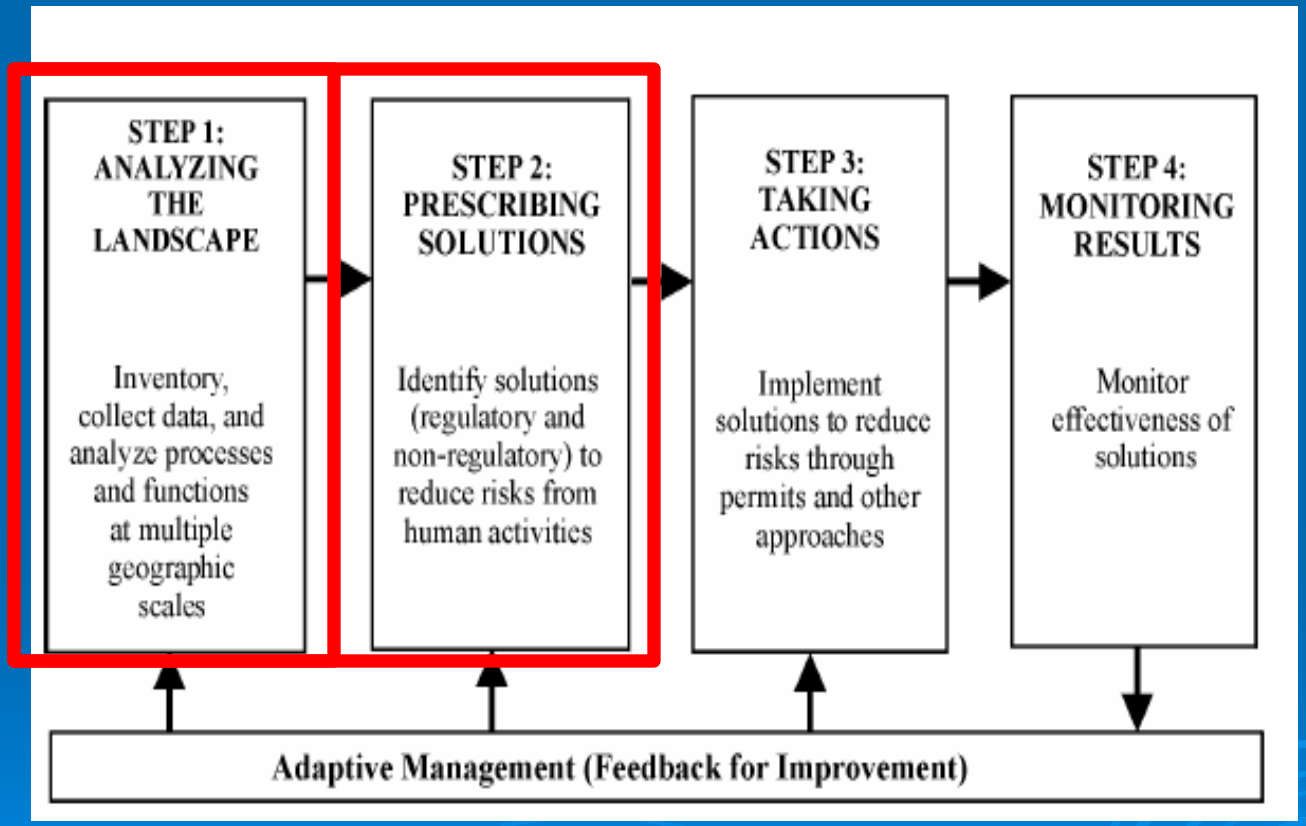


Understanding of Important Areas can help…

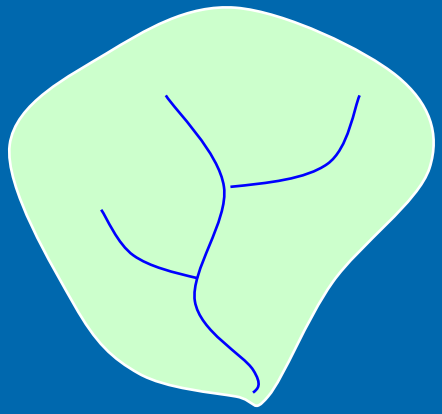
Guide future development

- Avoid creating environmental problems
- Reduce cost of infrastructure
- Streamline permitting
- Support Growth Management and Shoreline Management Planning

Watershed Based Planning Process

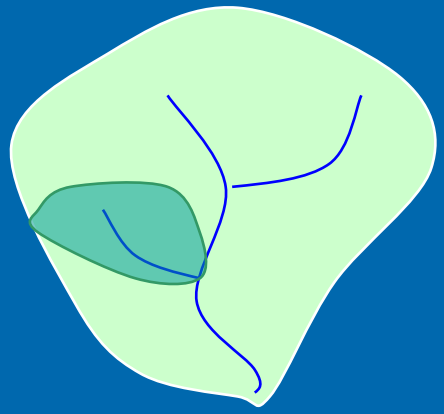


Multiple Scales of Watershed Analysis



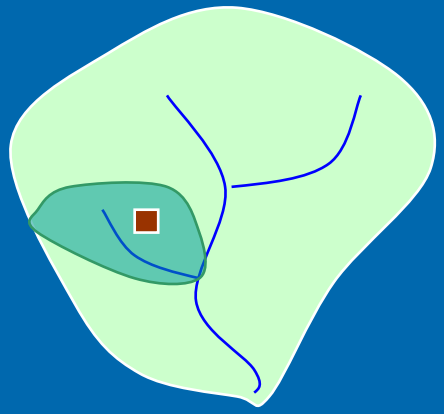
Broad-scale:

- County
- River Basin



Mid-scale:

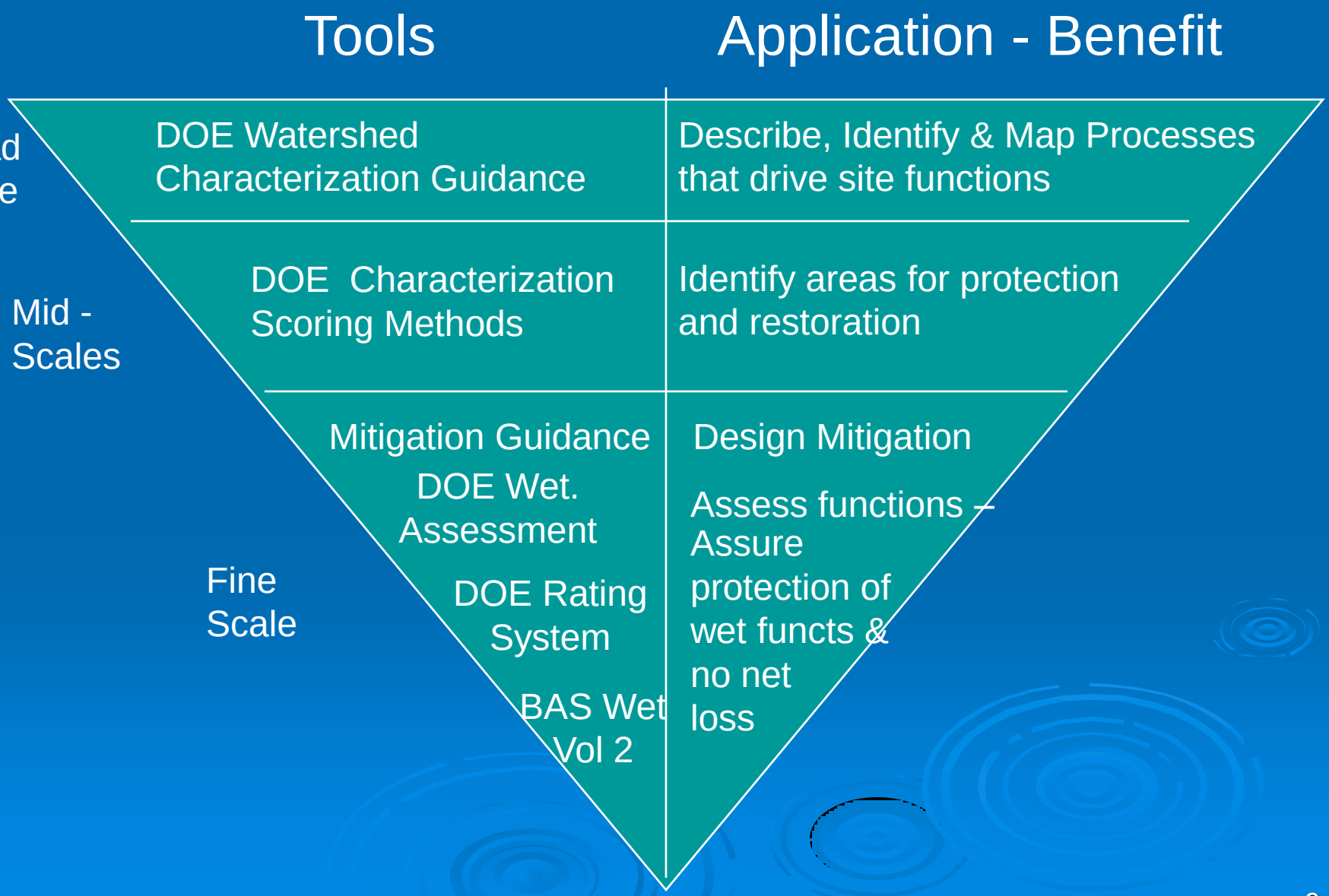
- Sub-Area
- Watershed

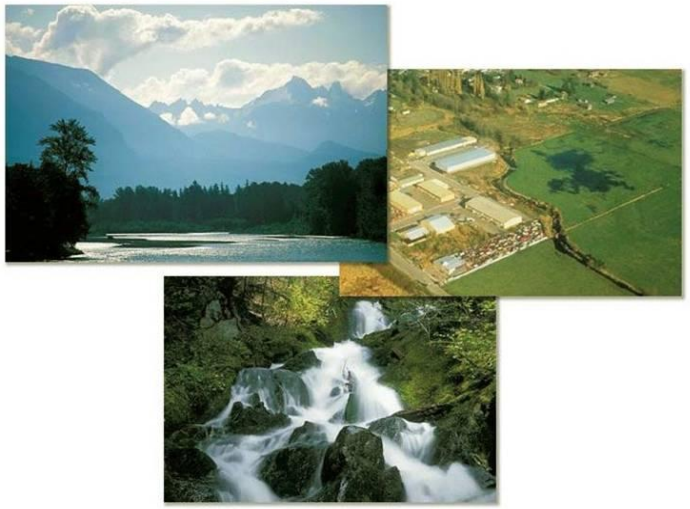


Fine-scale:

- Subdivision or Parcel

Tool box for Watershed Approach





Protecting Aquatic Ecosystems by Understanding Watershed Processes

A Guide for Planners

Ecology Publication #05-06-027

Introduction to Department of Ecology's Watershed Guidance

January 2009

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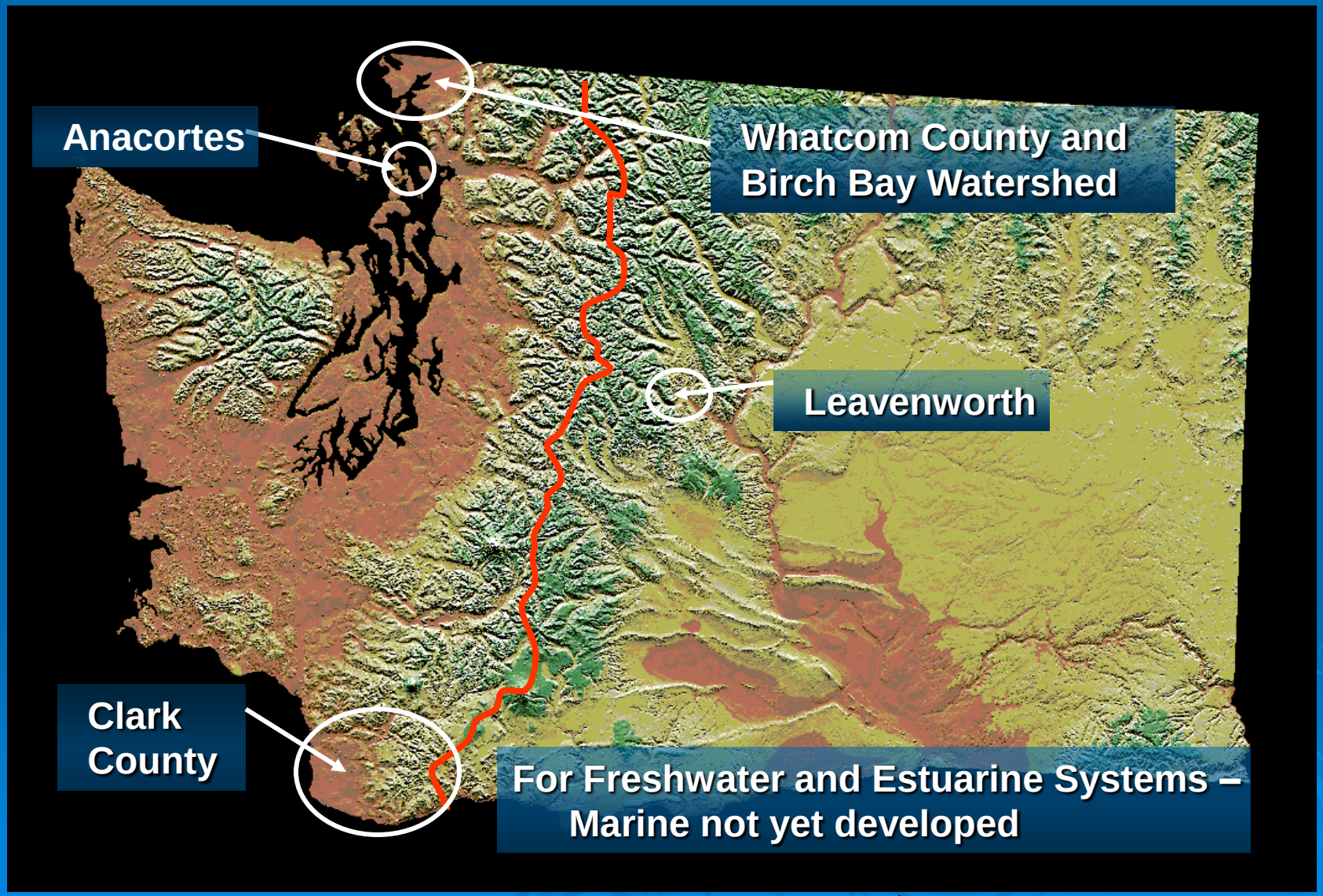
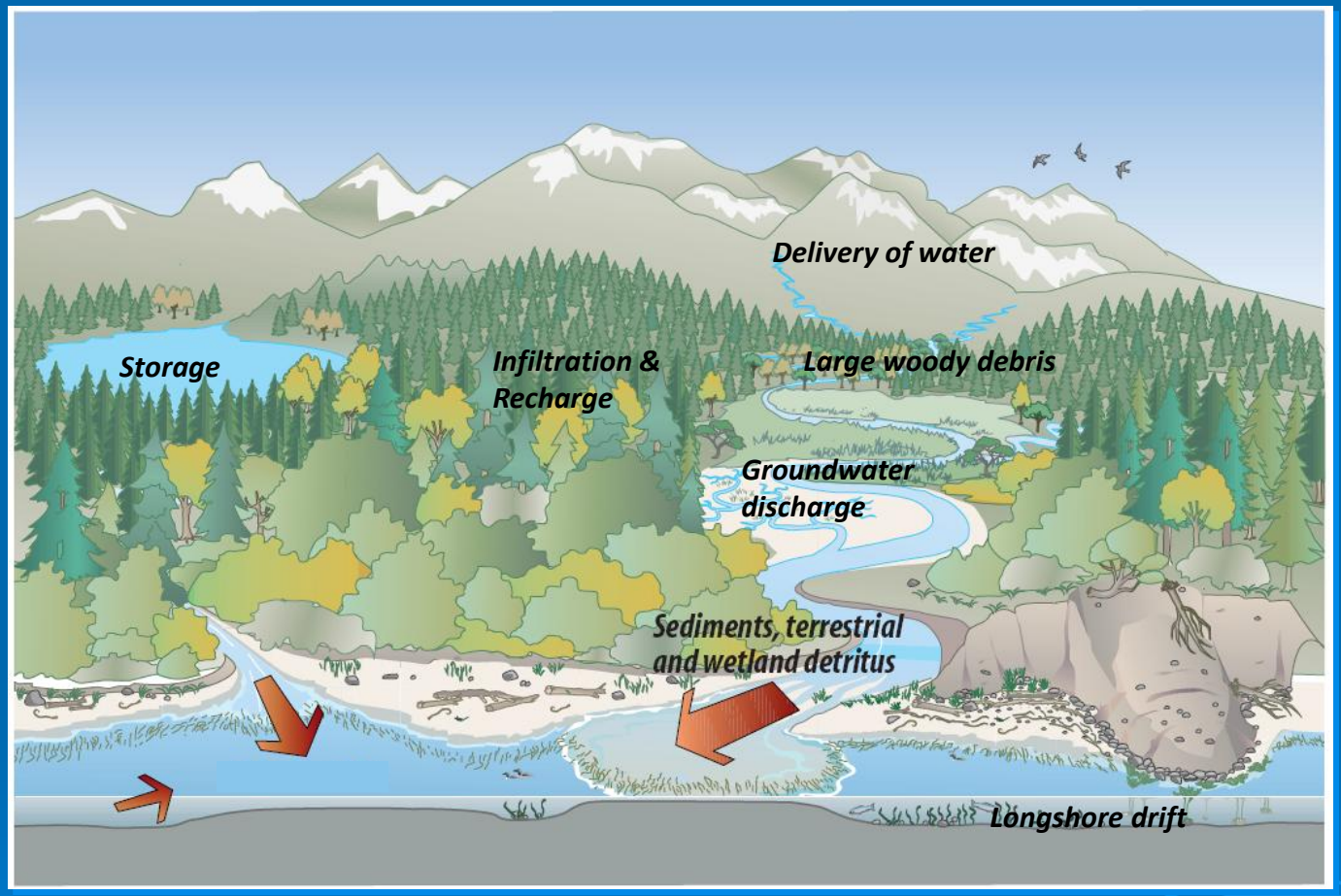
Guidance is For Western Washington



Objectives of Guidance



Identify Important Areas for Supporting Watershed Processes

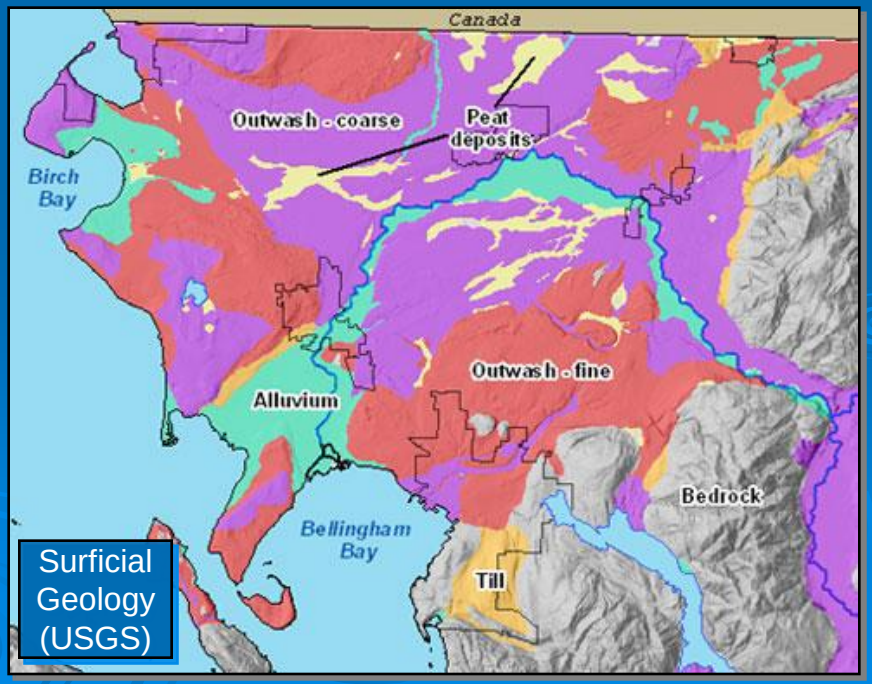
And How Those Areas Have Been Altered

Identifies the best areas to protect, restore, & develop

This Guidance is based on hydrogeologic setting…

Physical characteristics of the landscape:

- Aquatic resources develop and are maintained due to interaction of hydrologic cycle with landscape components including:
  - **Geology**
  - **Soils**
  - **Topography**



Surficial Geology (USGS)

Overview of Analysis Steps

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Steps	Key Questions	Details
Step 1: Define the purpose of the analysis.	What are the policy or regulatory issues for which you need to understand watershed processes? Who will assist you with the analysis? What resources already exist to help with the analysis?	Pg 6 & 7
Step 2: Delineate the analysis area, hydrologic sub-units and any hydrogeologic units.	What is the contributing basin for the area affected by policy or regulatory decisions? What size of the sub-units meets local planning and permitting needs? Are there different types of precipitation, landform and geology in the analysis areas?	Include surface water shed and contributing area for groundwater (if possible). Determine appropriate size for analysis units.
Step 3: Map the relative level of importance of each sub-unit for each watershed process.	In the absence of human impairment, what areas are important to each water shed process? Where are these different areas located?	Describe relationship between physical characteristics of a watershed and each watershed process.
Step 4: Map the relative level of	Which human activities have impaired each watershed	Describe relationship between

Step 1 – Define Purpose of Analysis

Table 1: Relationship between purpose, analysis area, and watershed processes requiring analysis.

Purpose	Analysis area	Watershed processes
Shoreline Master Program Comprehensive Plan Watershed Plan	Watersheds of jurisdiction	All
Mitigation Plan Conservation Plan Restoration Plan	Watershed of ecosystem or habitat	All
Plans for addressing environmental problems, e.g., TMDLs, shellfish closures, water quality violations, etc.	Watershed affecting area of concern	Processes associated with key issue

- Identify specialists to help in the analysis:
  - hydrologist, geologist, aquatic biologist, GIS analyst

Step 1 – Gather Information

Table 2: Selected sources of existing information and data

Type of information	Studies/plans	Website
TMDL studies and listings	Water bodies exceeding water quality standards (303d list)	http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/list_by_category-cat5.html
	TMDL clean up plans	http://www.ecy.wa.gov/programs/wq/tmdl/watershed/index.html
Habitat and water quality monitoring/ assessment reports	Puget Sound Action Team list of reports on marine environments	http://www.psat.wa.gov/Publications/Pub_Master.htm
Watershed planning reports	Ecology list of watershed planning reports	http://www.ecy.wa.gov/watershed/index.html
Studies/environmental reports	Limiting Factors Reports	http://salmon.scc.wa.gov
	Site-specific studies	Literature data bases, tribal websites, agency websites

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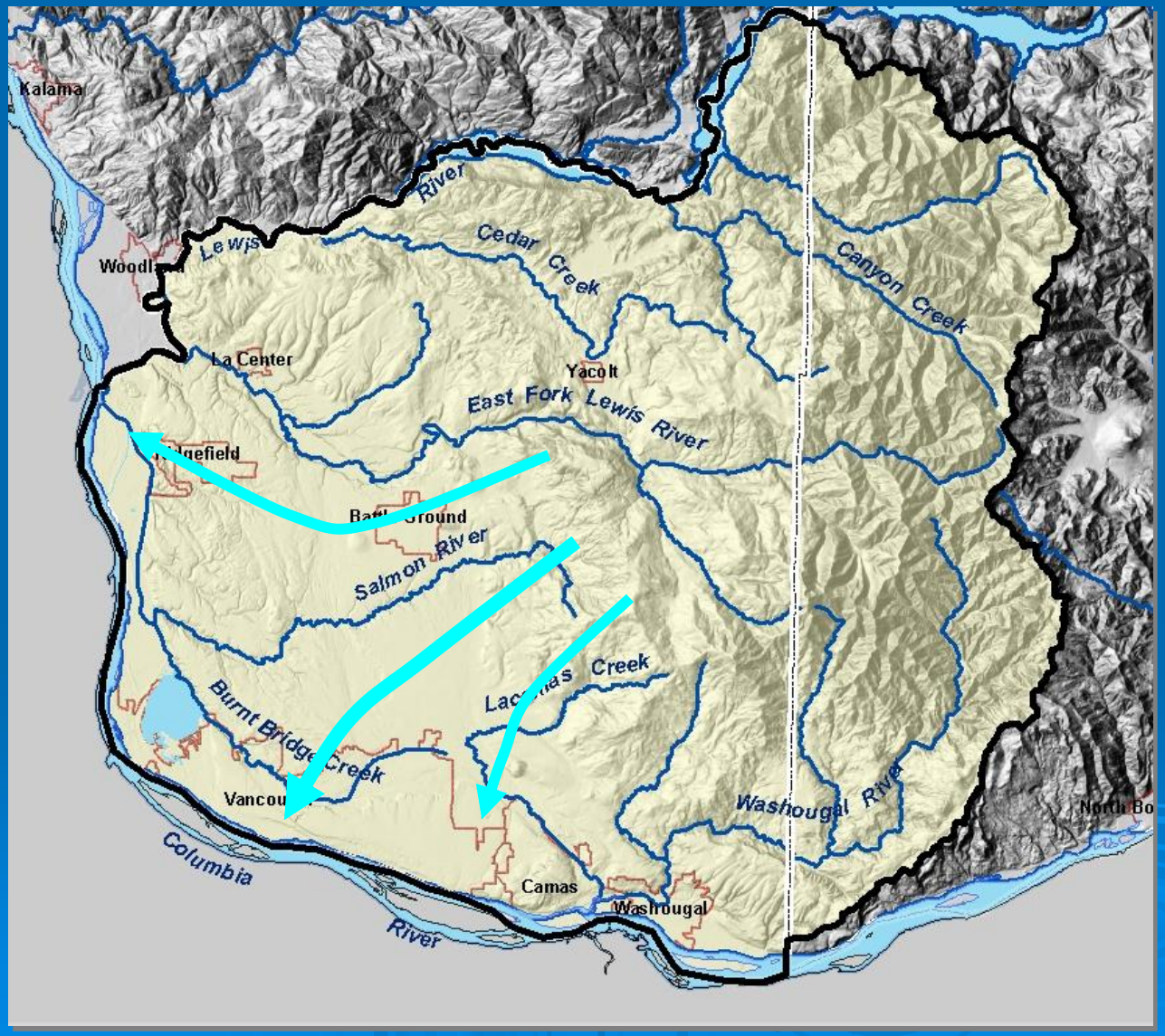
Step 2 – Delineate Analysis Area

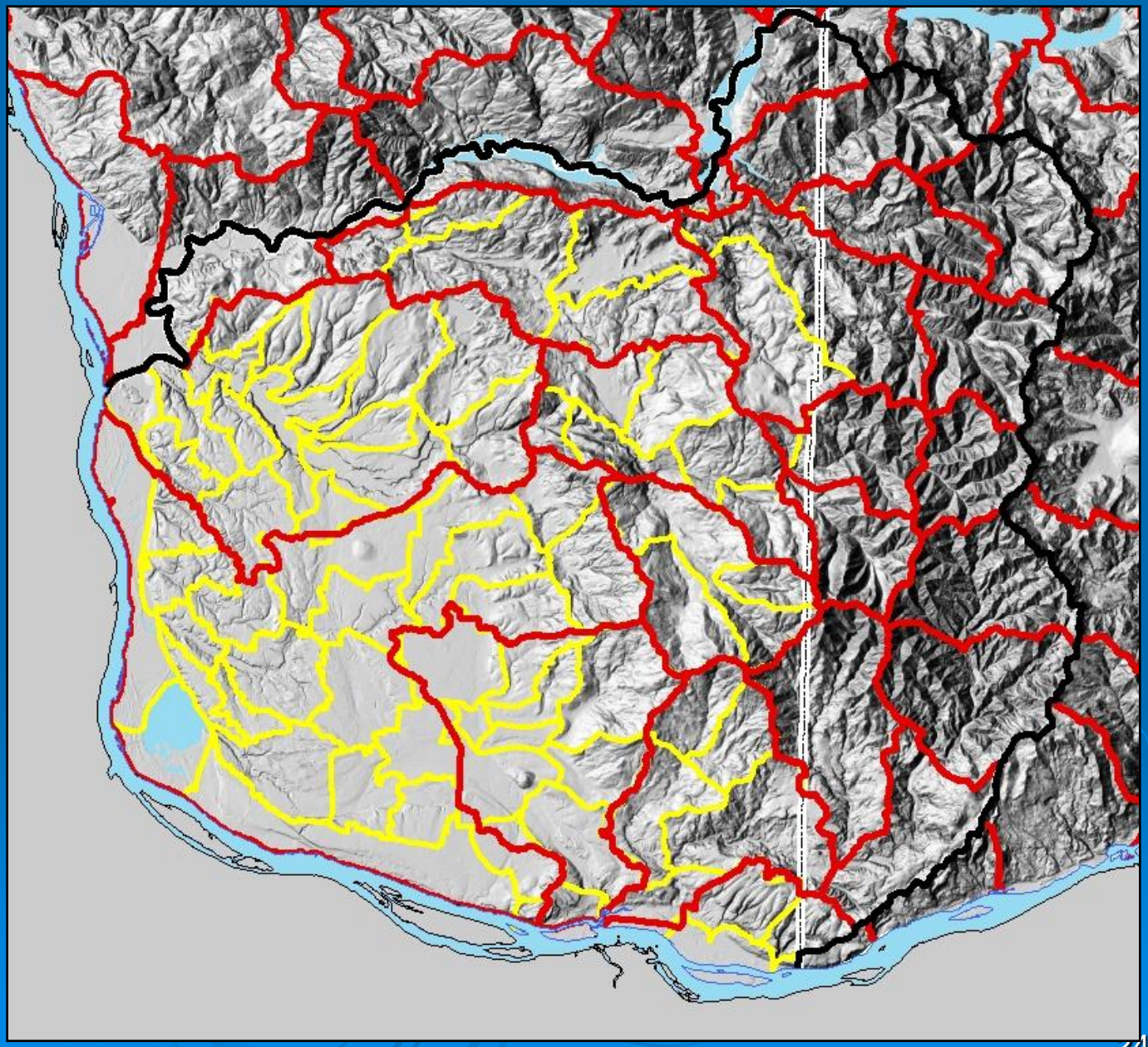


Step 2 – Create Sub-units

Step 2 – HUC's Are Too Large

USGS Hydrologic Unit Codes watersheds:

Usually too large for application in local plans



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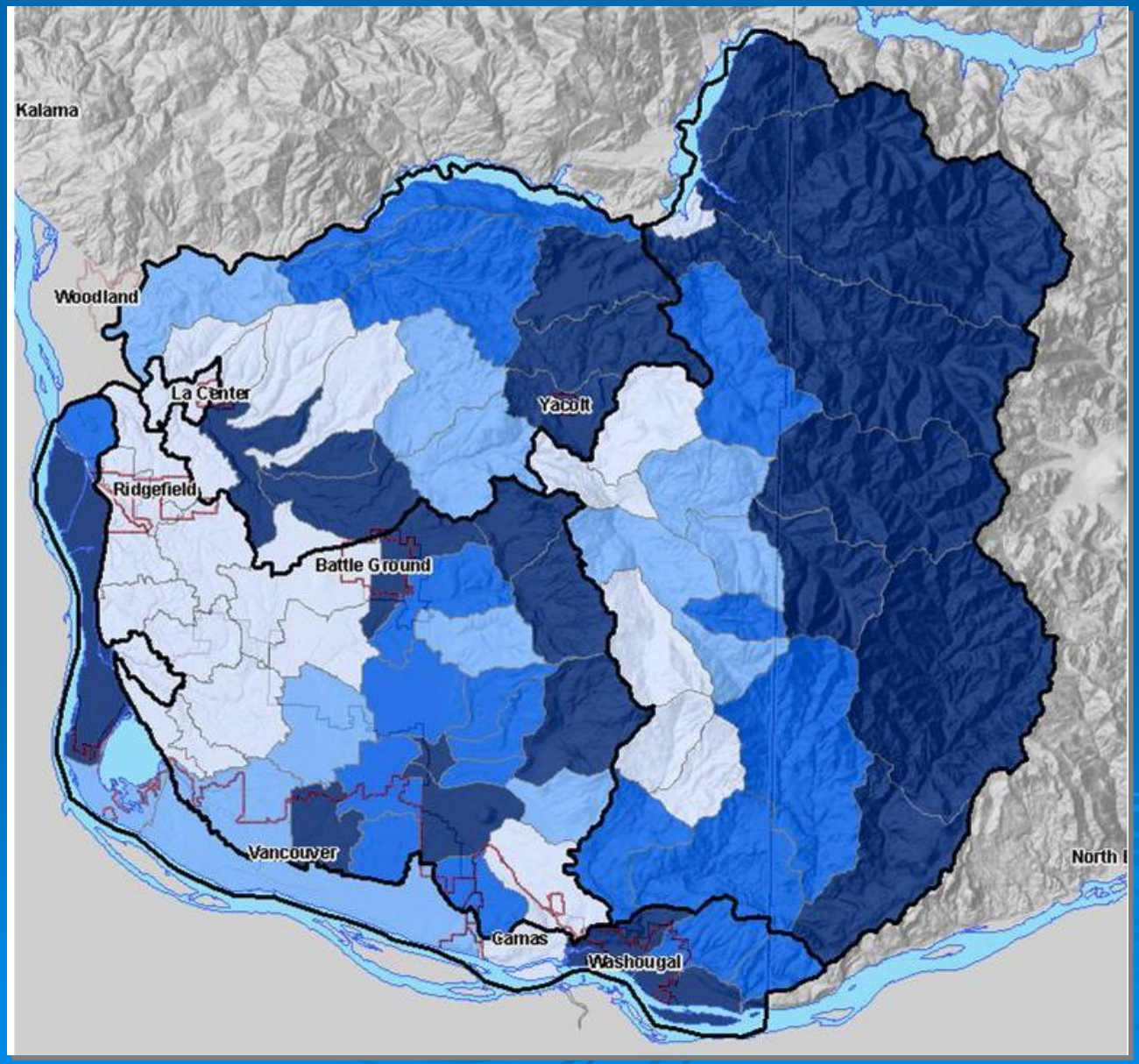
Step 3 – Map Important Areas



purpose of the analysis.

processes?
Who will assist you with the analysis?
What resources already exist to help with the analysis?

Pg 6 & 7

Step 2: Delineate the analysis area, hydrologic sub-units and any hydrogeologic units.

What is the contributing basin for the area affected by policy or regulatory decisions?
What size of the sub-units meets local planning and permitting needs?
Are there different types of precipitation, landform and geology in the analysis areas?

Include surface water shed and contributing area for groundwater (if possible). Determine appropriate size for analysis units.

Step 3: Map the relative level of importance of each sub-unit for each watershed process.

In the absence of human impairment, what areas are important to each water shed process?
Where are these different areas located?

Describe relationship between physical characteristics of a watershed and each watershed process.

Step 4: Map the relative level of impairment to each watershed process.

Which human activities have impaired each watershed process?
Where have these activities most impaired processes?

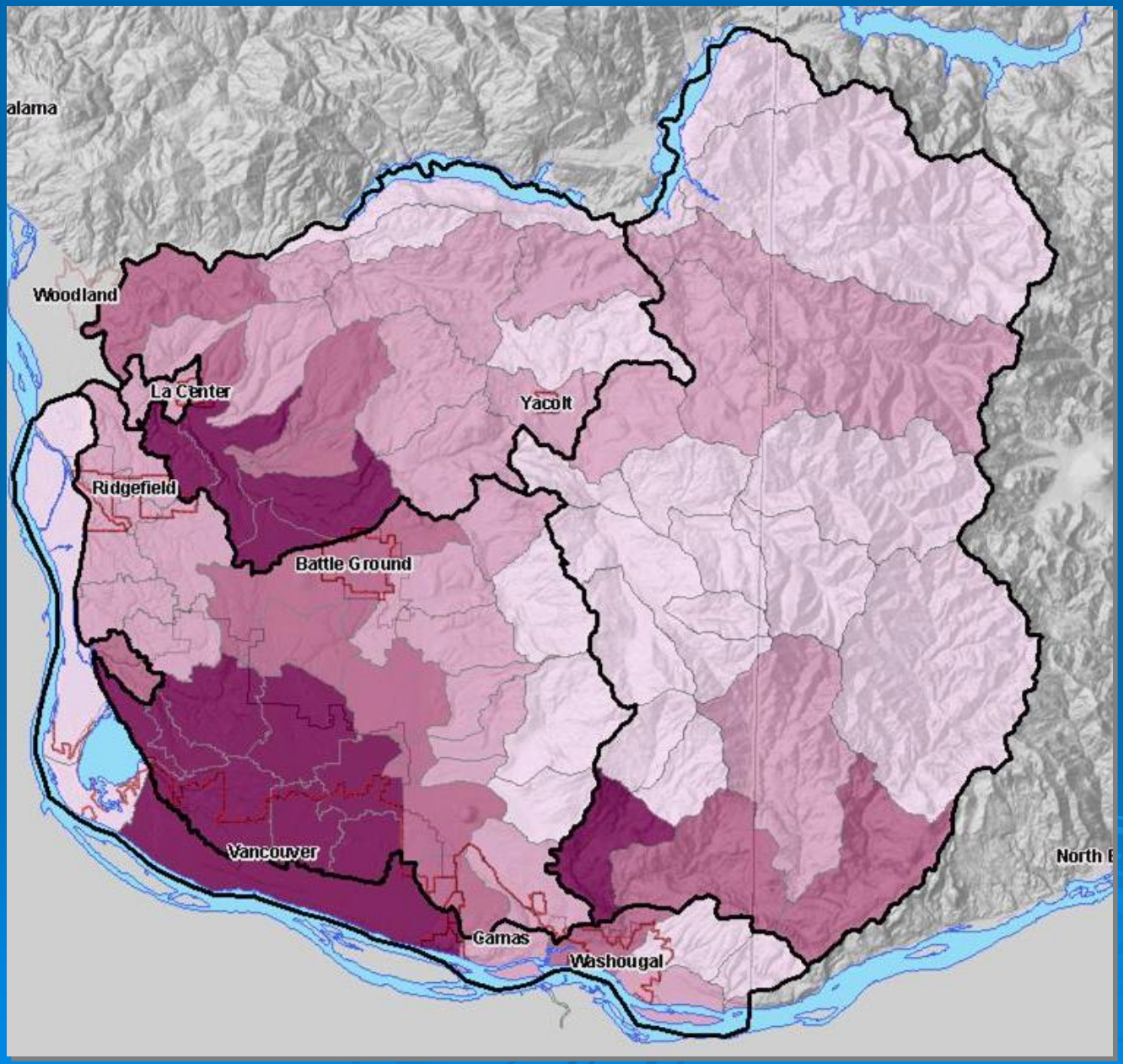
Describe relationship between human activities and each watershed process.

Step 5: Identify the

Where are watershed

Combine Map of Impairments and

Step 4 – Map Impairments



hydrologic sub-units and any hydrogeologic units .

meets local planning and permitting needs?
Are there different types of precipitation, landform and geology in the analysis areas?

groundwater (if possible).
Determine appropriate size for analysis units.

Pg 6 & 7

Step 3: Map the relative level of importance of each sub-unit for each watershed process.

In the absence of human impairment, what areas are important to each watershed process?
Where are these different areas located?

Describe relationship between physical characteristics of a watershed and each watershed process.

Step 4: Map the relative level of impairment to each watershed process.

Which human activities have impaired each watershed process?
Where have these activities most impaired processes?

Describe relationship between human activities and each watershed process.

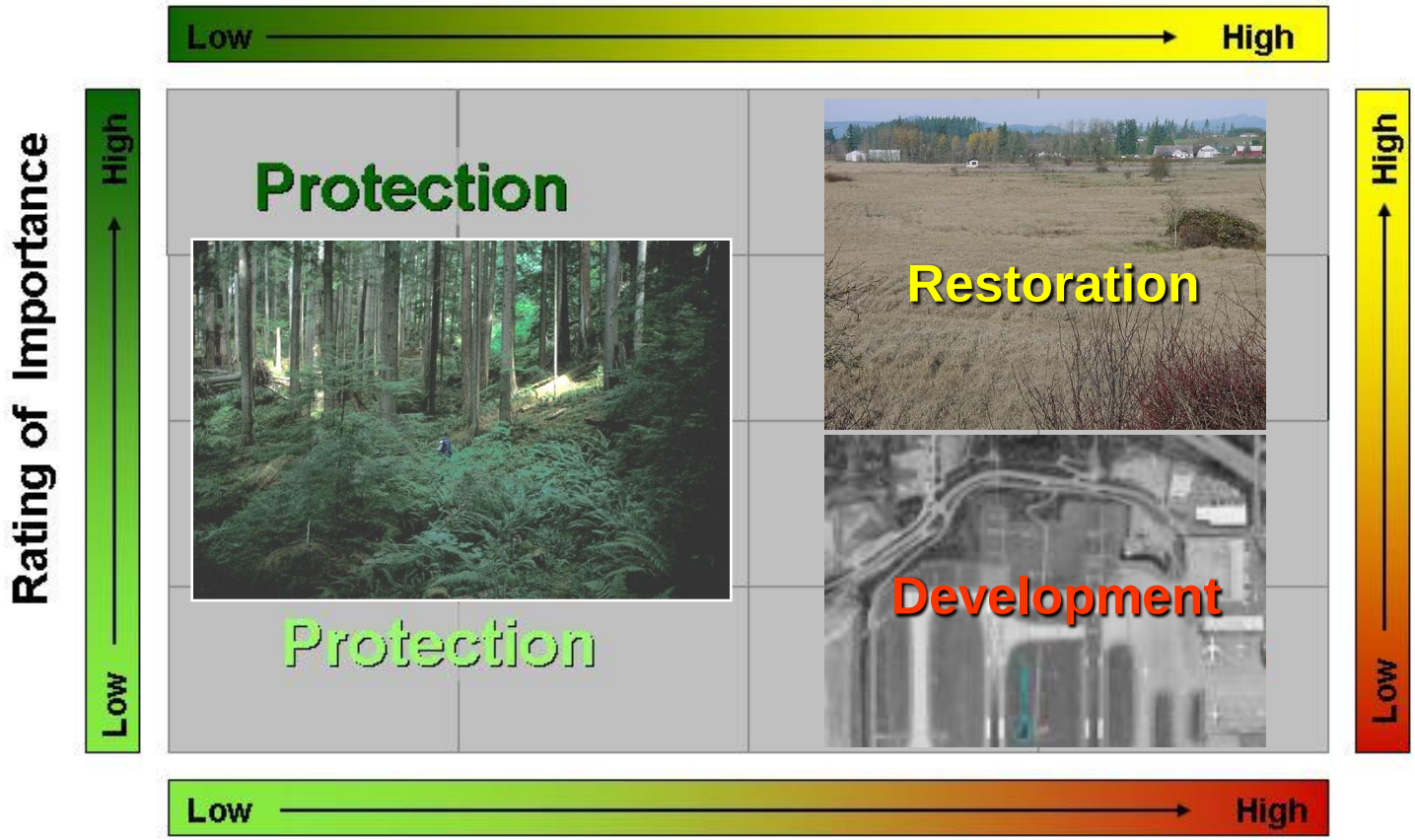
Step 5: Identify the most suitable areas for protection, restoration & development.

Where are watershed processes still intact or minimally impaired?
Where have watershed processes been impaired?

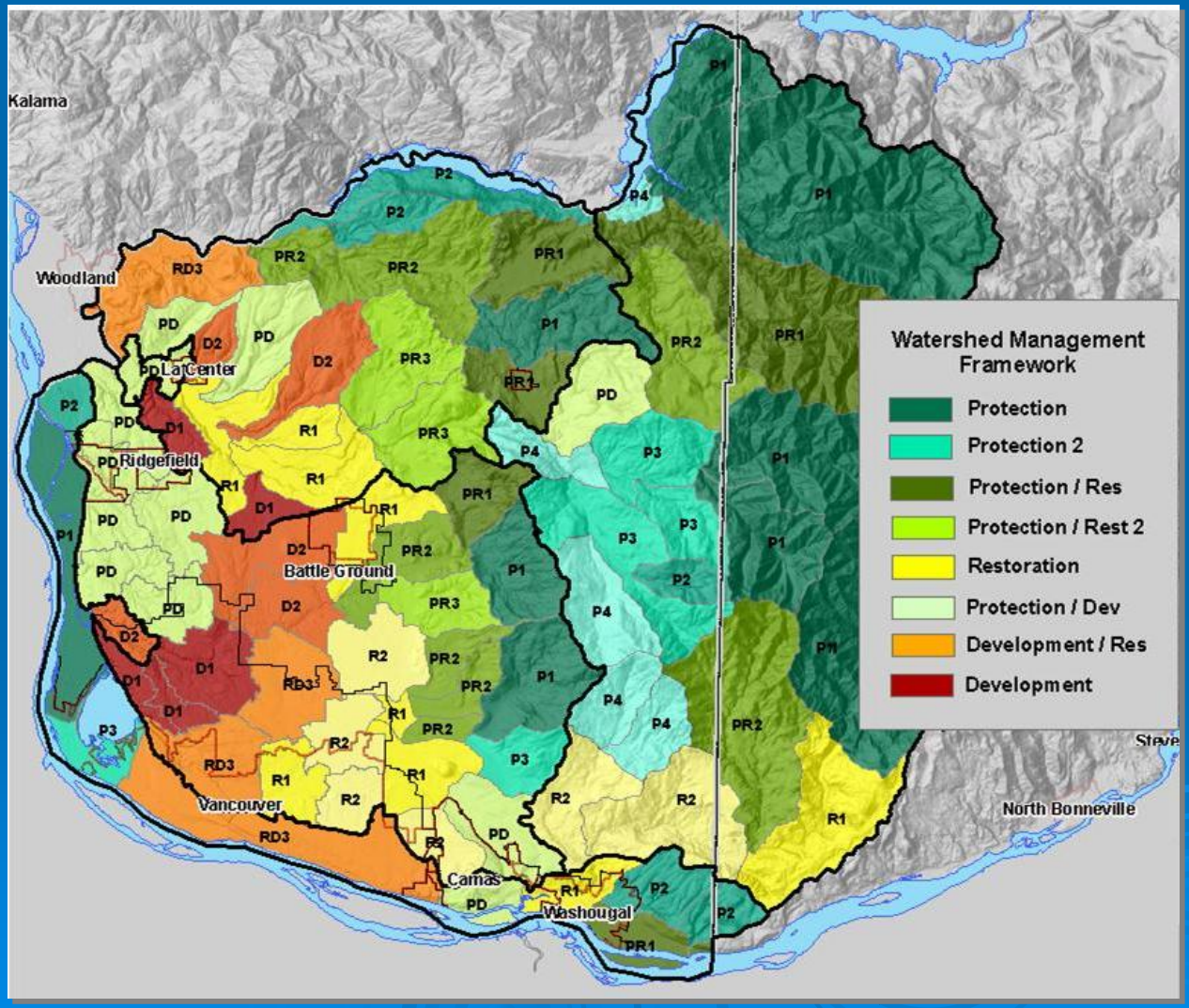
Combine Map of Impairments and Map of Important Areas for each watershed process;
Unimpaired → protection
Impaired → restoration or development

Step 5 – Locate Areas for Protection and Restoration

Watershed Management Matrix



Step 5 - Locate Areas for Protection and Restoration



Overview of Appendices

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Appendices A to G – What they cover

Appendix B: Characterizing the Water Process in Western Washington

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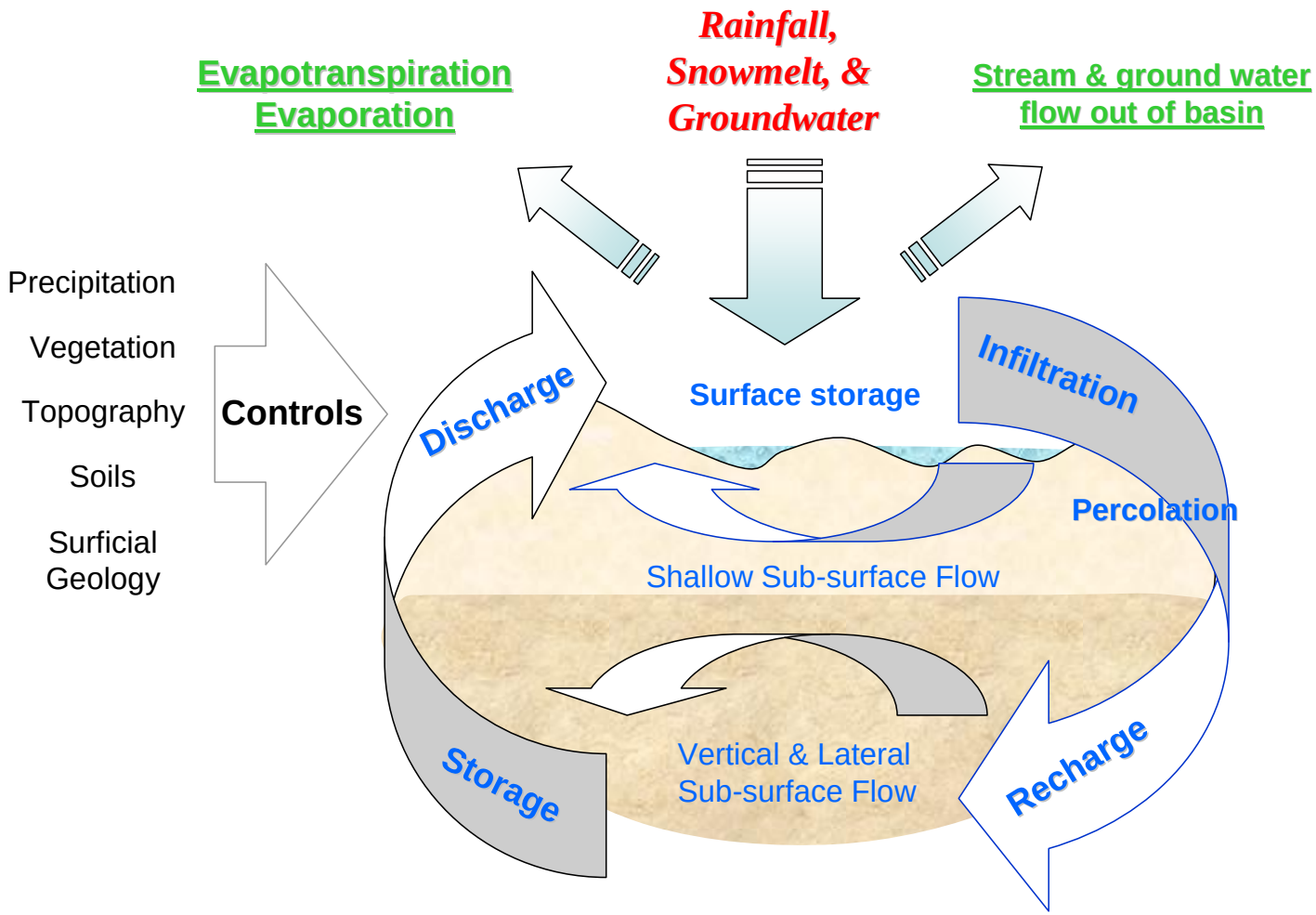
Appendices B to G – Methods for Unaltered Areas

Process: *Delivery* , Movement , & Loss of Water



Pg. B- 4

Table B-1 : Describe Components, Controls & Key Areas

Pg. B-10 Component of Process			Major Natural Controls	Important Areas	Variable for Scoring Importance
Delivery			Precipitation patterns	**Recharge areas with higher amounts of precipitation**	**P**
			Timing of snowmelt	**Rain-on-snow zones** **Snow-dominated zones**	**HU1**
Movement	*At the surface*	Overland flow	Precipitation patterns & Soils	Saturated areas	
		Surface storage	Topography,Sur-face geology Soils	**Areas of low gradient** **Floodplains**	**HU2** **HU3, HU4, HU5**
	Below surface	Shallow subsurface flow	Topography Surface geology	**Low permeability deposits**	
		Recharge		**High permeability deposits**	**HU6**
		Vertical and lateral subsurface flow		Entire watershed	
		Subsurface storage	Surface geology	Deep permeable deposits	
	Return to surface	Discharge	Topography Surface geology	**Slope breaks (steep above, gentle below) intersecting permeable deposits** **Slope breaks intersecting area of hydric soils extending into lower gradient area** Stratigraphic pinchouts Contact areas between geologic deposits of different permeabilities	**HU7, HU8, HU9, HU10**
Loss		Evaporation/ Transpiration	Vegetation Climate	Entire watershed	Addressed in impairments
		Stream or sub-surface flow out of basin	Topography Surface geology		

Methods for Impairments

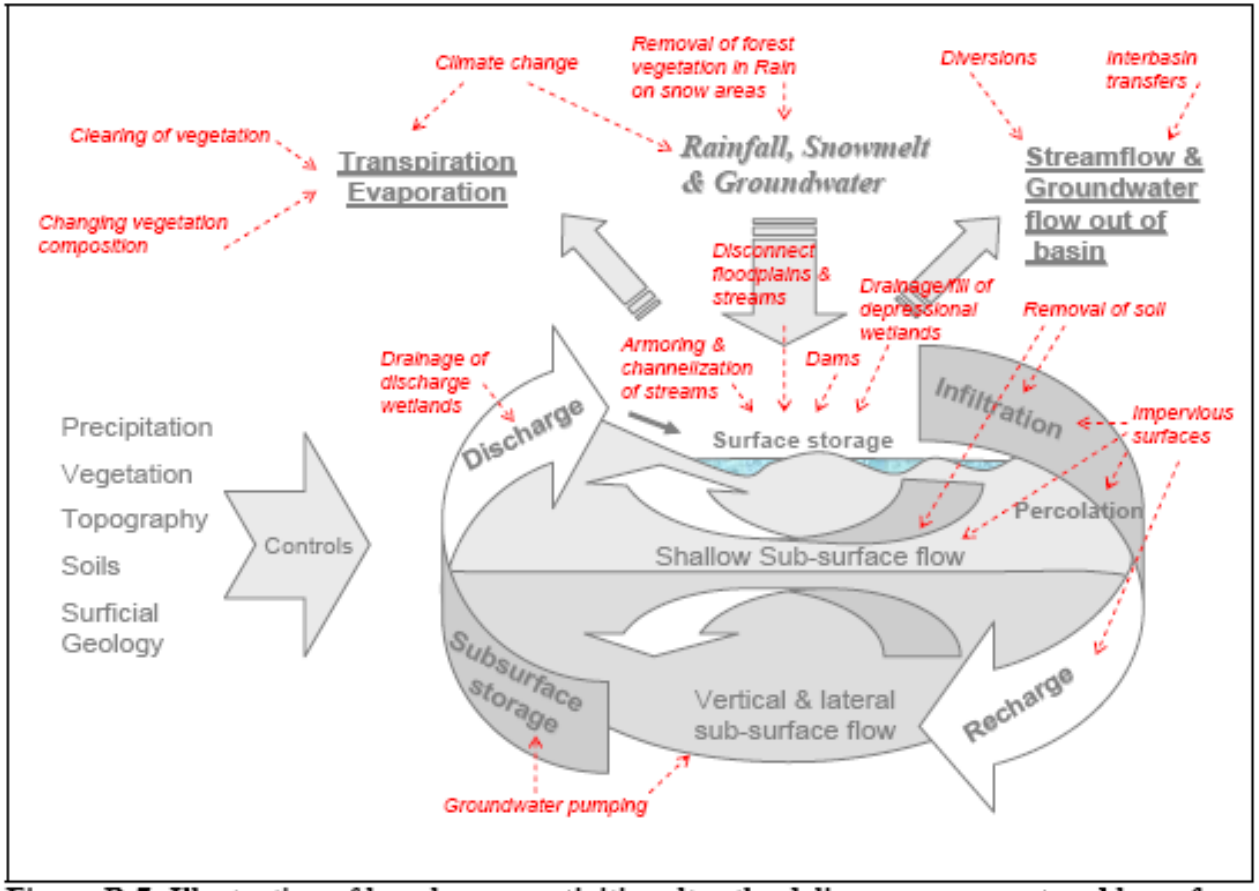


Figure B-7: Illustration of how human activities alter the delivery, movement and loss of water.

Pg. B- 20

Table B-3 : Describe Impairments

Component of process			Major natural controls	Change to process	Cause of change	Indicators of impairment	Variable for scoring in model
Delivery			Precipitation patterns	Changes in runoff quantity & timing	Climate change		
			Timing of snowmelt	Increase streamflow	Removal of forest vegetation	**Reduction of forest cover in rain-on-snow and snow dominated zones**	**HI-1**
Movement	*At the surface*	Overland flow	Precipitation patterns Soils	Change timing of surface runoff Decreased infiltration	Impervious areas Channelization of flows Filling and draining of seasonally saturated areas	**Watershed imperviousness** Stormwater discharge pipes Drainage ditches in seasonally saturated areas Loss of seasonally saturated areas	**HI-2**
		Surface storage	Topography Surface geology Soils	Increase streamflow Decrease storage capacity Increase velocity of surface flows	Drainage or filling of depressional wetlands	**Rural & urban land use Loss of depressional wetlands**	**HI-3, HI-4**
					Channelization of streams	**Miles of stream through urban areas**	**HI-5, HI-6**
					Disconnection of stream from floodplain	Dikes and levees on stream reaches with floodplains	
				Increase water storage capacity Decrease downstream flow	Dam operation	Dams	

Pg. B-22

Appendix H – GIS Methods

GIS Analysis for Important Areas	Watershed Processes											
	Water		Nitrogen		Pathogens		Sediment		Phosphorous /Toxins		LWD	
		Mvt		Mvt	Mvt	Loss		Mvt		Mvt		Mvt
Precipitation patterns	P		See Impairments									
Rain-on snow and snow dominated zones	HU1											
Depressional wetlands		HU2		NU1	PU1	PU4		HU2		HU2		
Channel confinement (storage)		HU3 HU4 HU5			PU3		X	X		HU3	HU3	
Permeability of surficial geology (recharge areas)		HU6			PU2							
Channel confinement and permeability (discharge)		HU7 HU8 HU9		NU2								
Lakes				NU3				NU3		NU3		
Erodible soils & steep slopes							X		X			
Mass wasting areas intersected by aquatic ecosystems							X				X	
within 100' of aquatic ecosystems											X	
Channel gradient												X

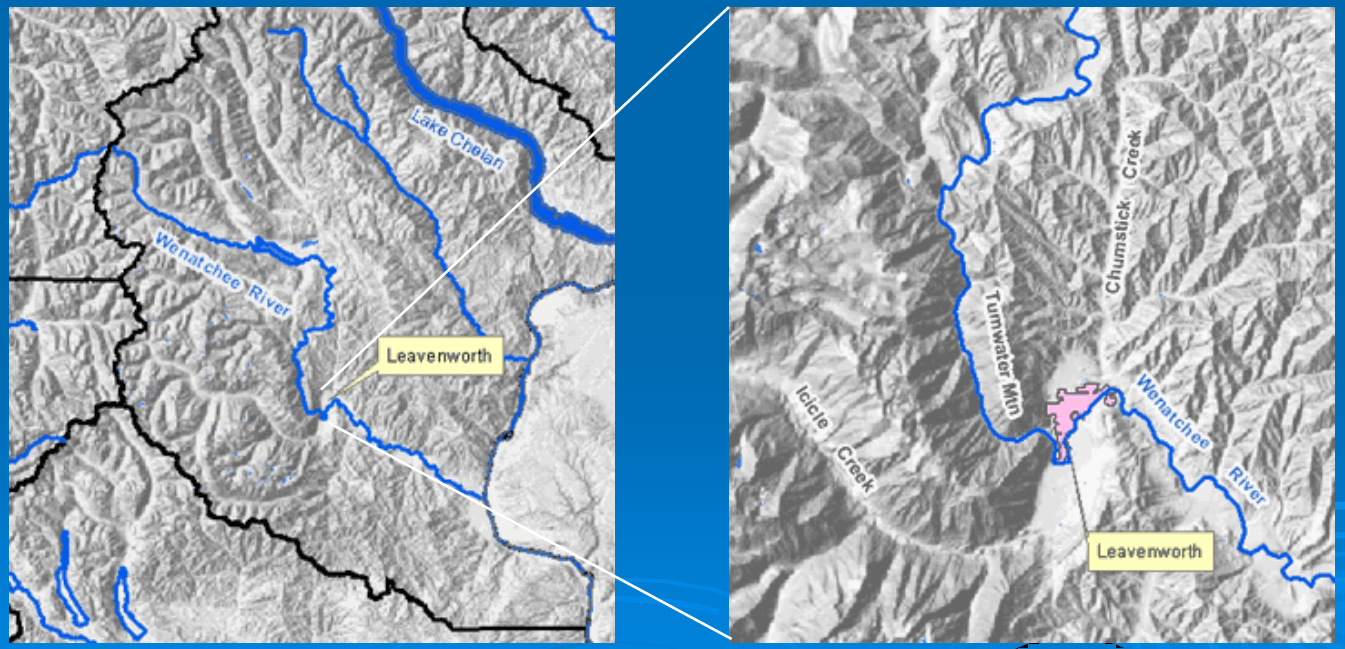
Example of Watershed Characterization

City of Leavenworth

Watershed Analysis at the Sub-basin Scale

Based on
Leavenworth Water Problem Study of 1999

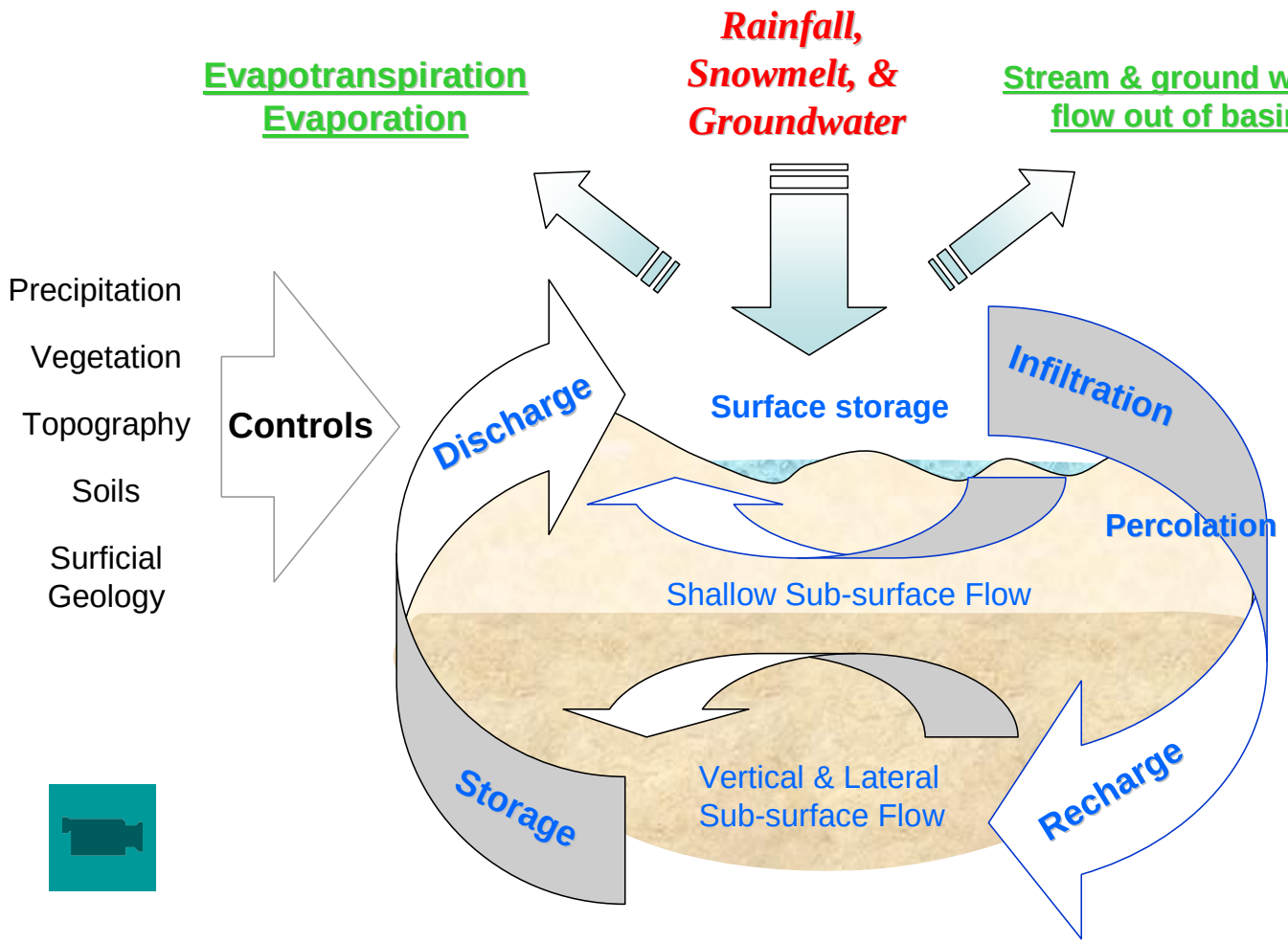
Additional input from Matt Karrer, Hydrologist, US Forest Service



WASHINGTON STATE DEPARTMENT OF ECOLOGY

How Water Moves Through a Watershed

Process: *Delivery* , Movement , & Loss of Water



Methods

Step 1 – Define purpose of analysis

Step 2 – Map analysis area and analysis units

Step 3 – Identify and Map Key Areas

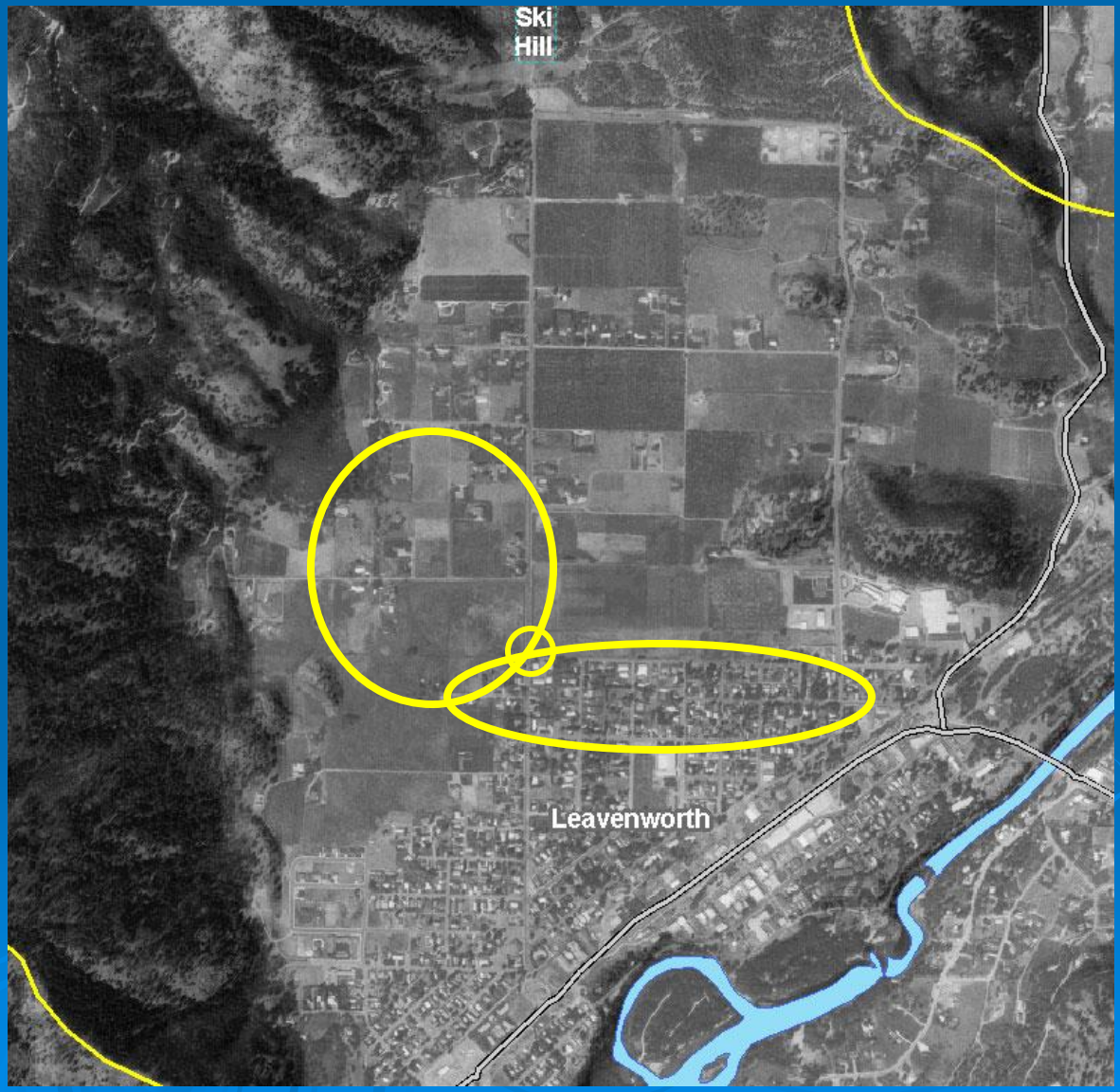
Step 4 – Identify and Map Types of Impairments

Step 5 – Locate areas for protection and restoration

Incorporate Results into Planning

Step 1 – Define Purpose of Analysis

- Flooding problems
  - Sheet flooding
  - Culvert flooding
  - Subsurface flooding of basements
- Previous wetland study (1999)
- Identify local experts

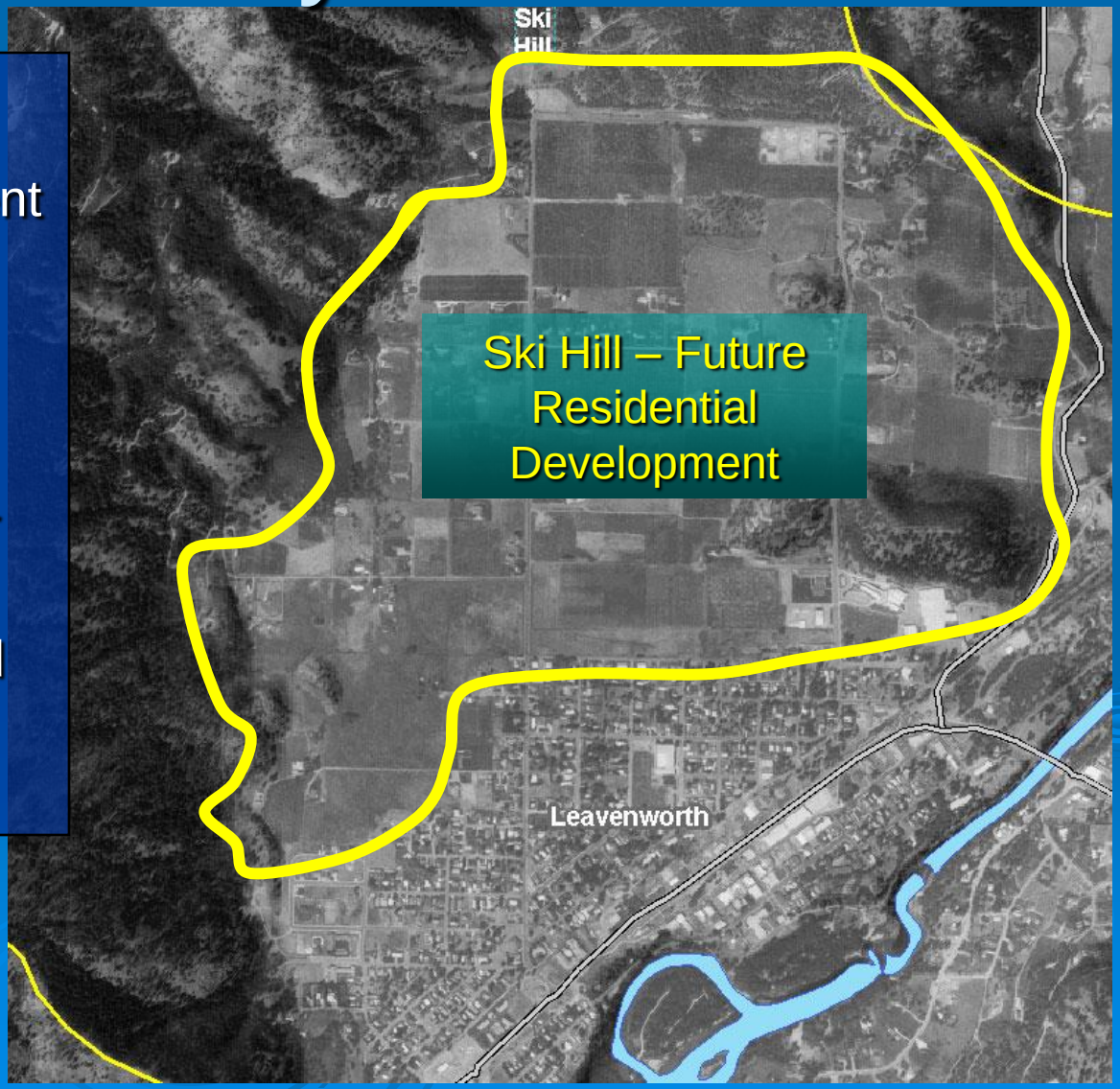


Step 1 – Define Purpose of Analysis

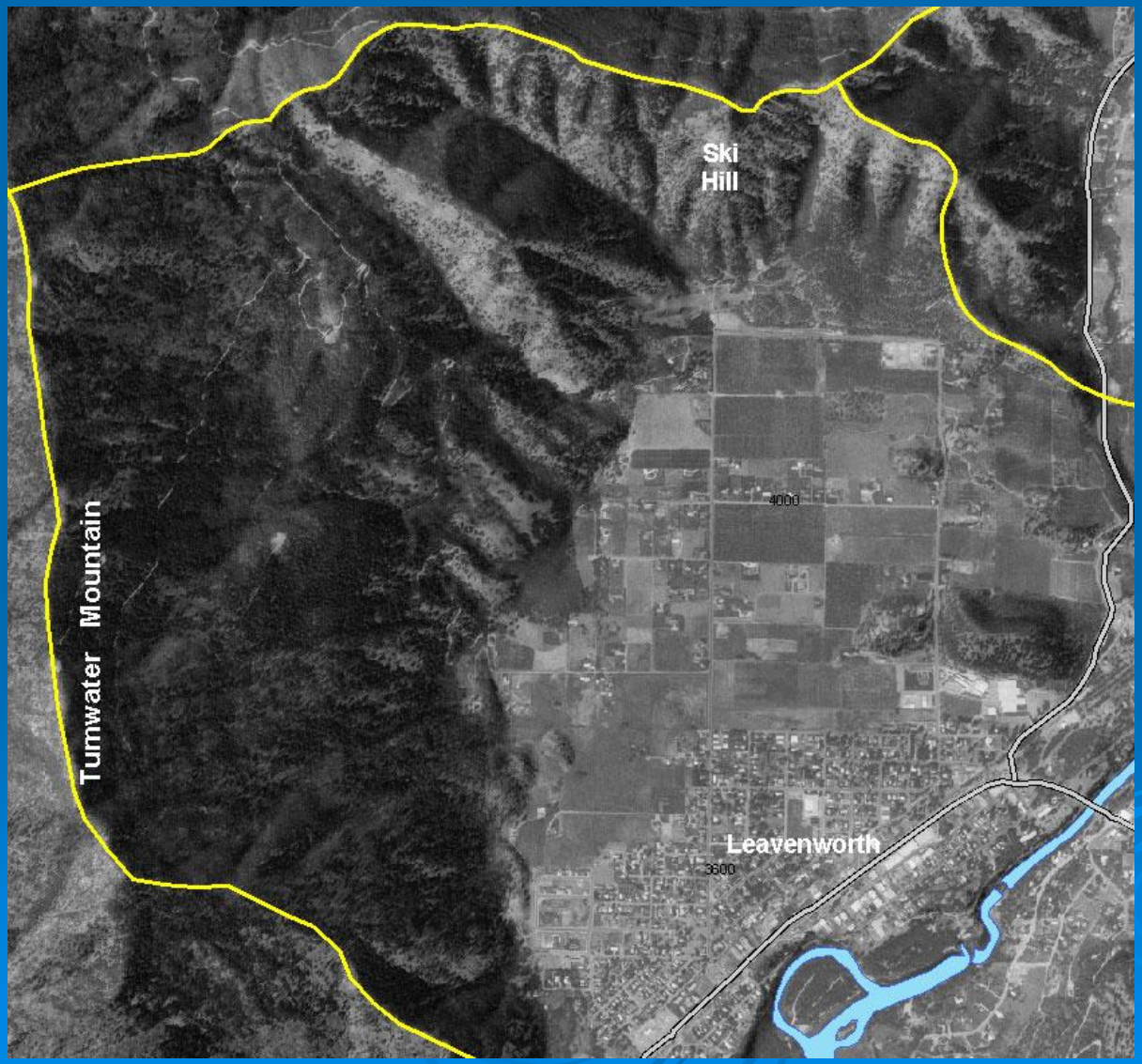
City wants to develop a green infrastructure plan for residential development in upper Ski Hill.

The plan must show:

- ✓ Areas most suited for development
- ✓ Areas to be protected
- ✓ Area suitable for restoration



Step 2 – Delineate the analysis area

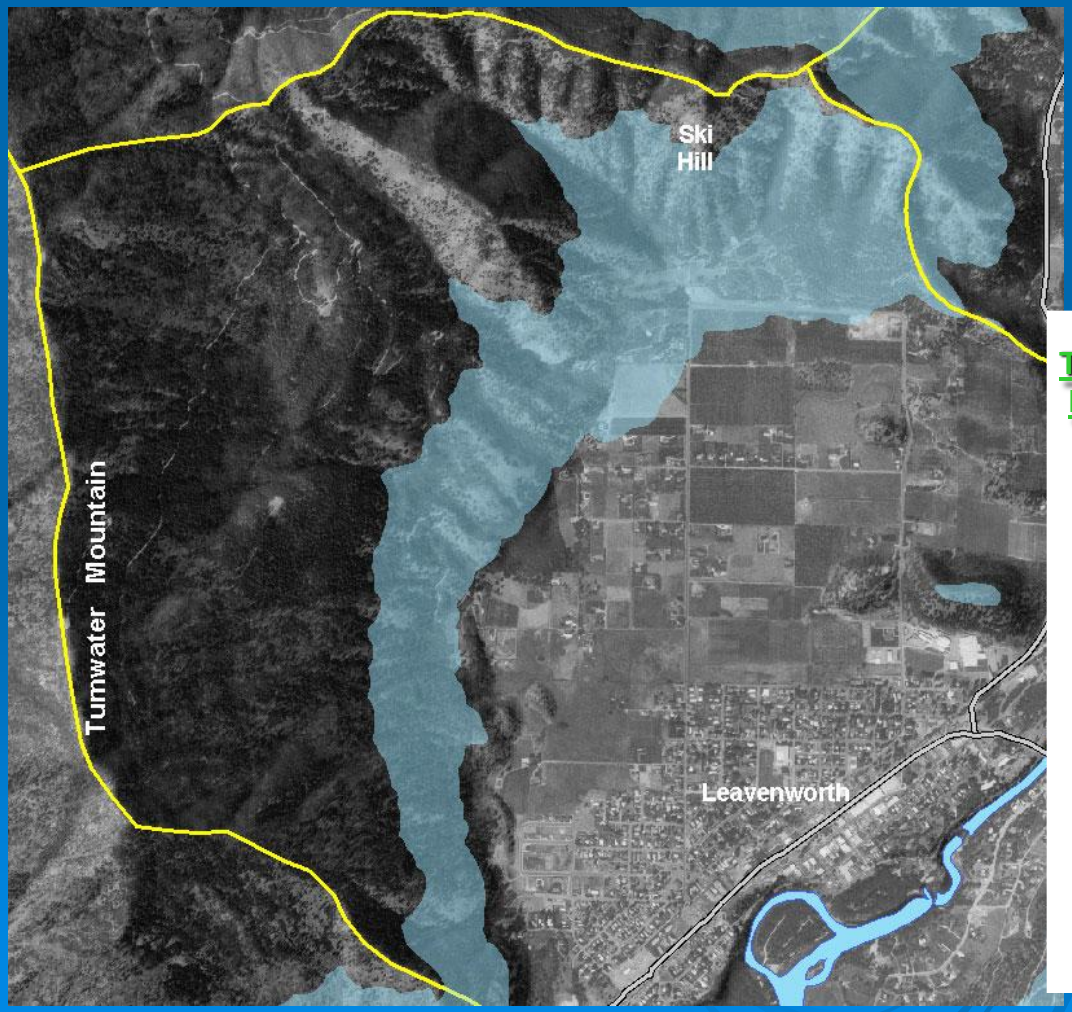


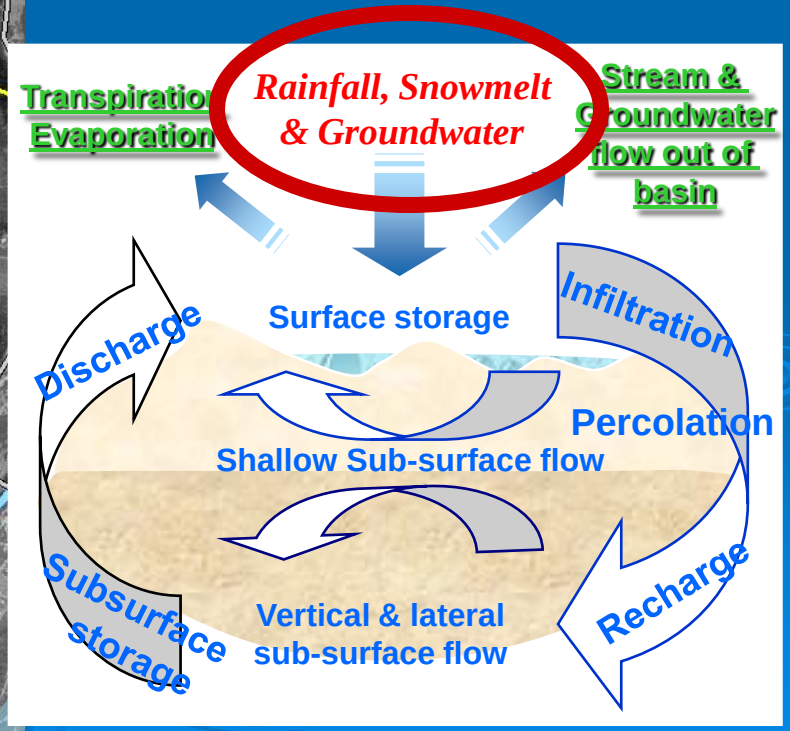
Step 3 – Identify and map important areas – surface water flow

- Rain on Snow
- Surface Storage: depressional wetlands & floodplains
- Recharge
- Storage Capacity
- Discharge Areas

Delivery of Water

Component of process	Important areas for process
Snowmelt/runoff	Rain-on-snow zone

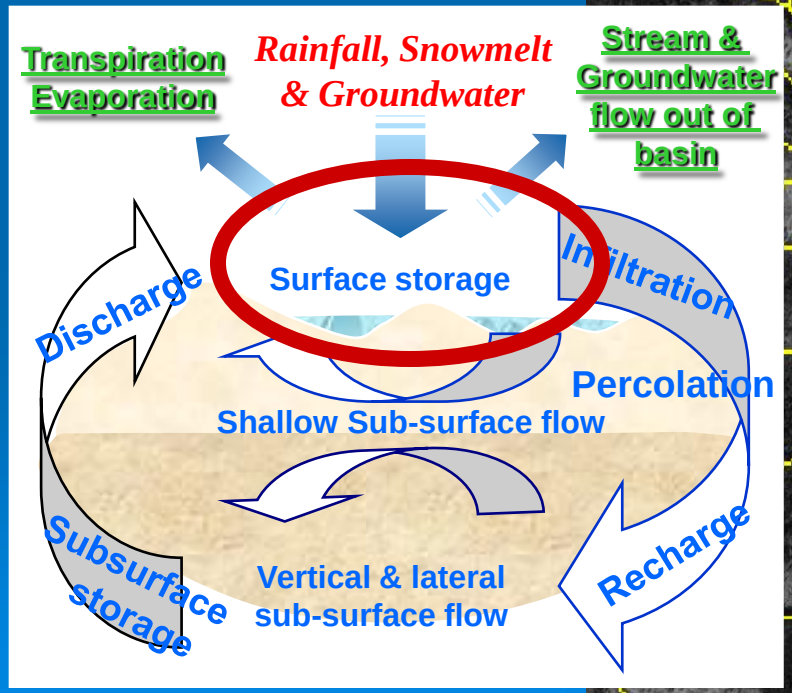


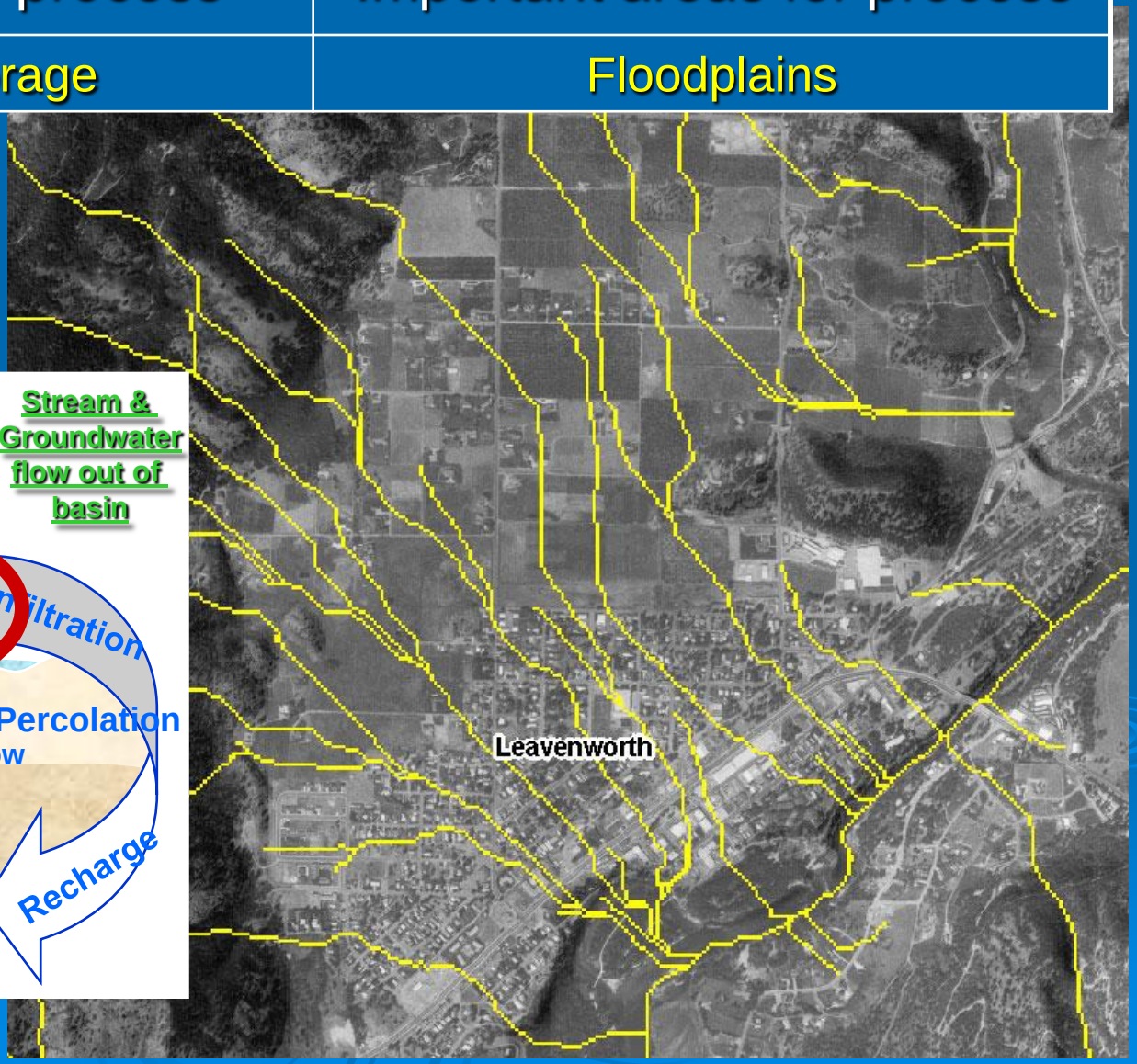


Movement of surface water

Component of process	Important areas for process
Surface storage	Floodplains

Probable historic drainage network.





Wetlands – Potential & Existing

Potential Wetlands

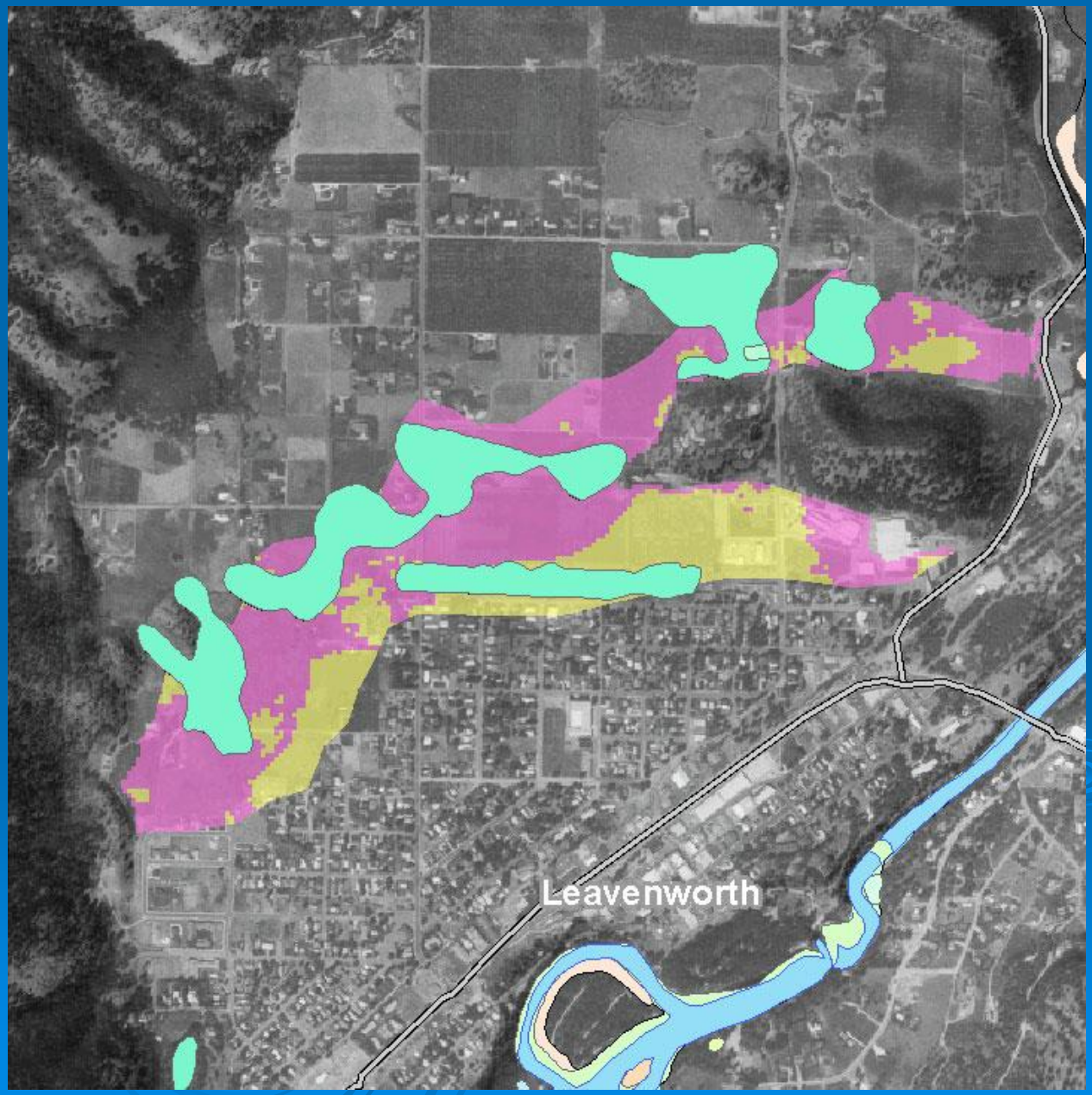
Depressional Wetlands:

Hydric soil & <4% slope

Slope Wetlands:

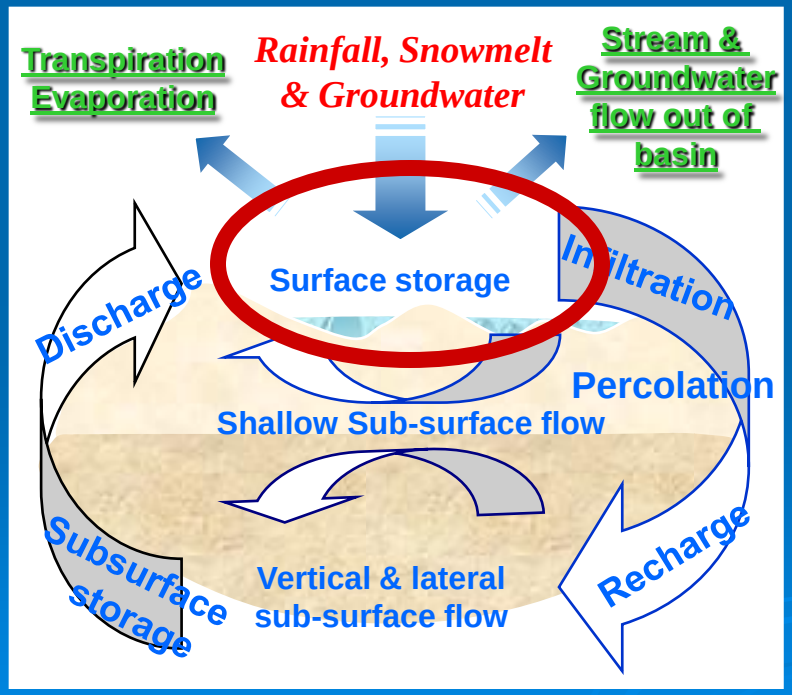
Hydric soil & 4-8% slope

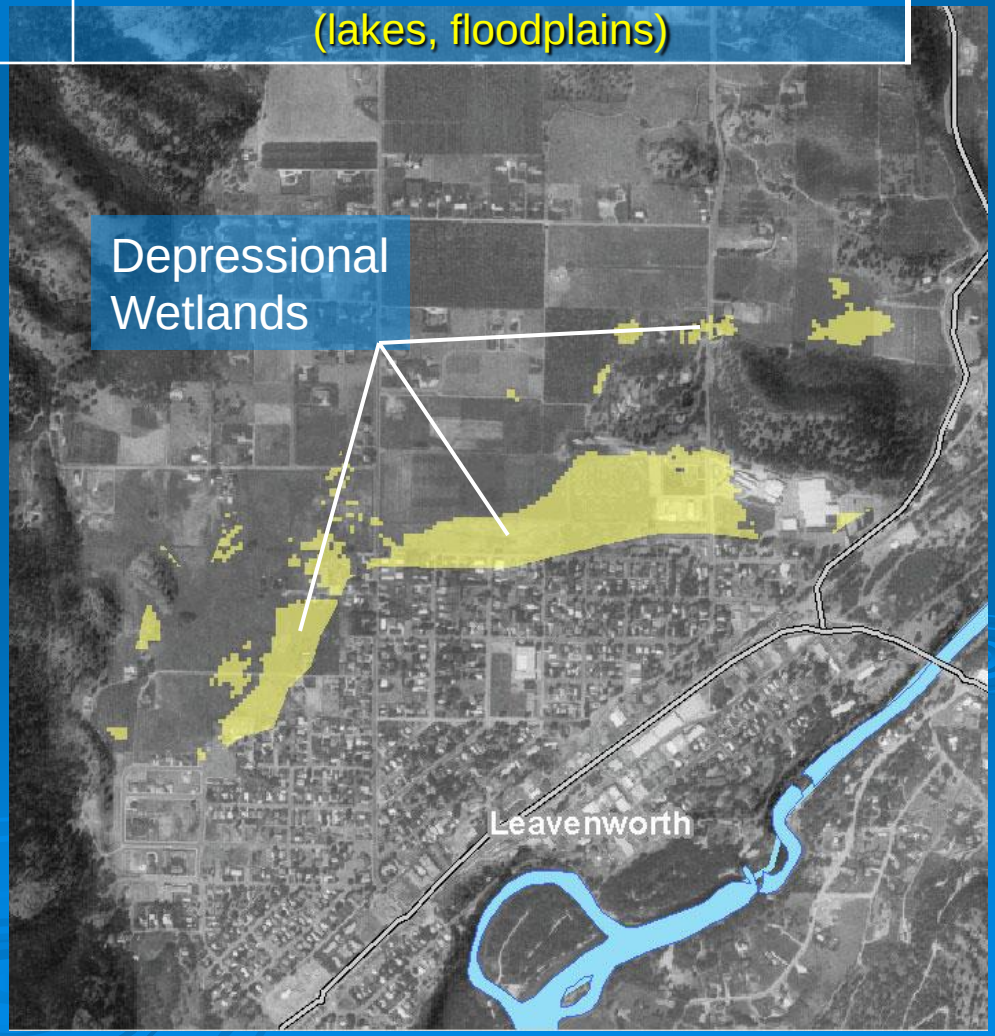
Existing Wetlands



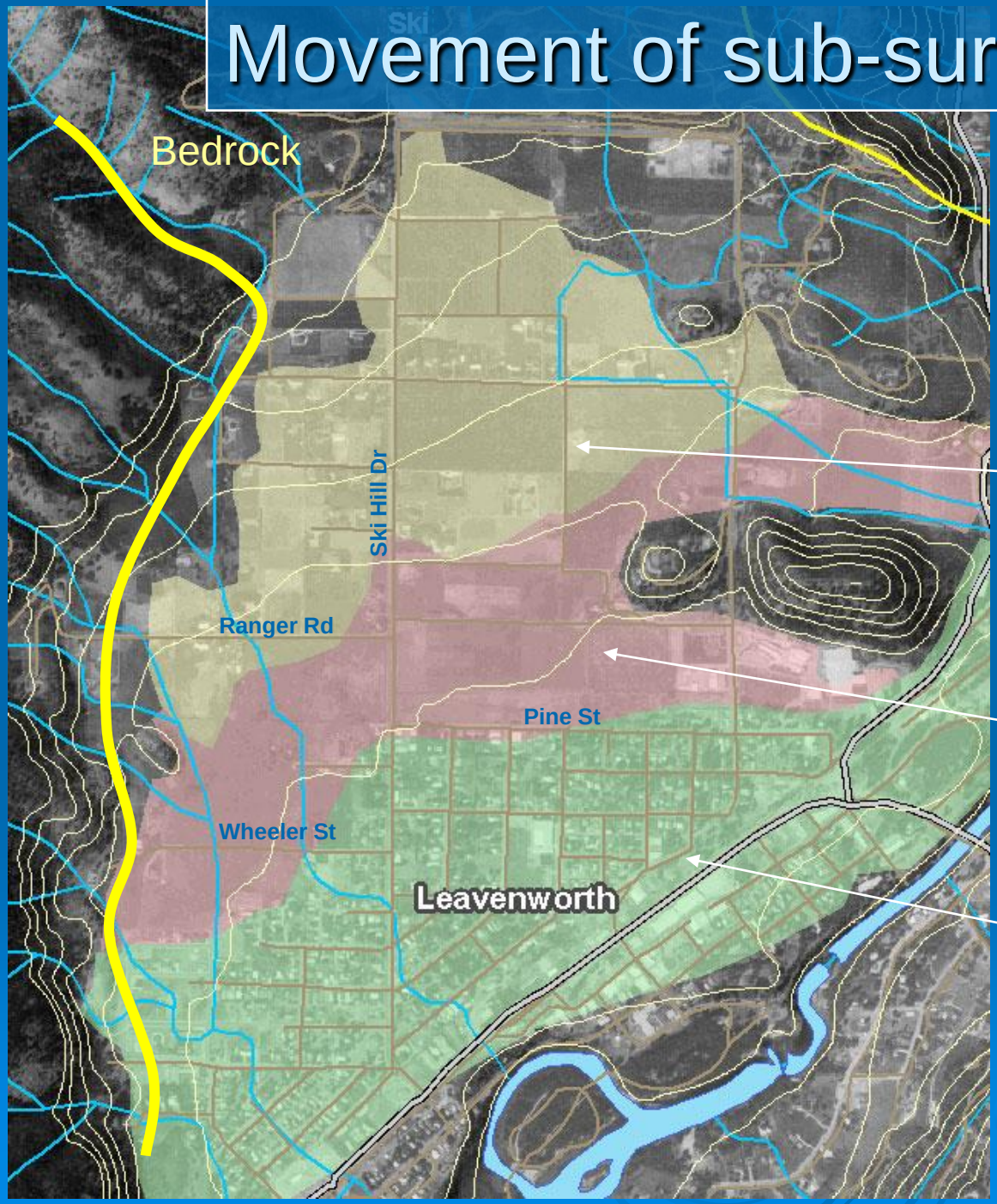
Movement of surface water

Component of Process	Important areas for process
Surface storage	Depressional wetlands (lakes, floodplains)





Movement of sub-surface water



Surficial Geology

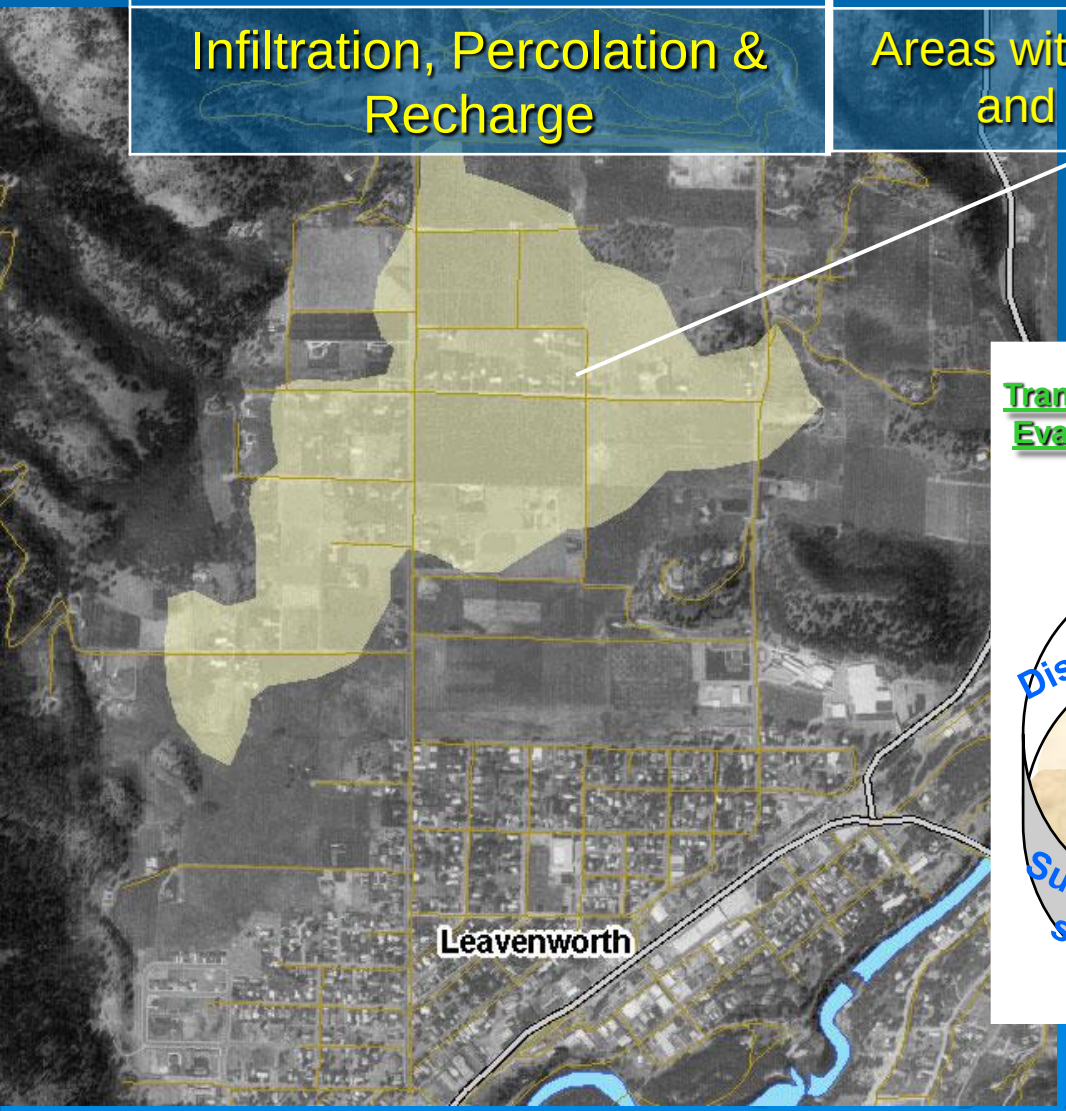
Older Alluvium – courser material

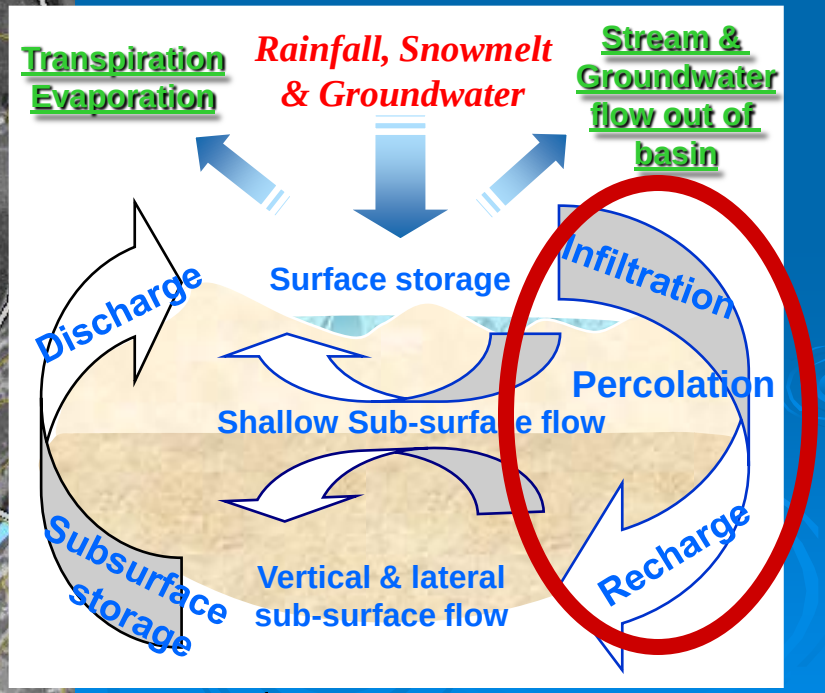
Older Alluvium – finer material

Till

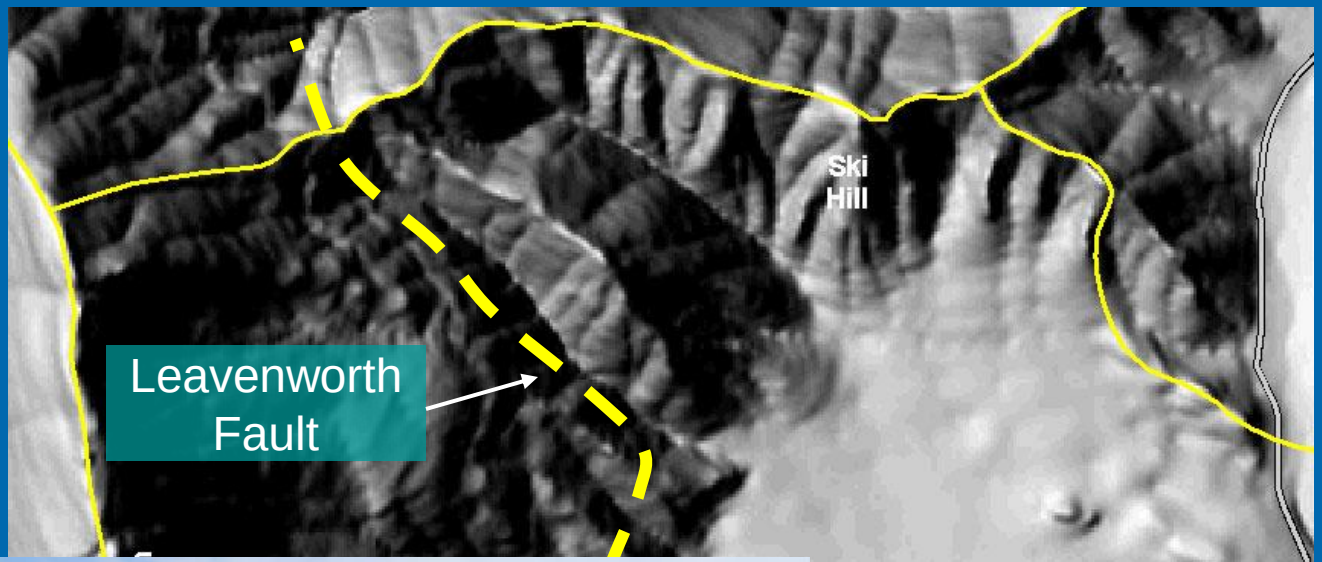
Movement of sub-surface water

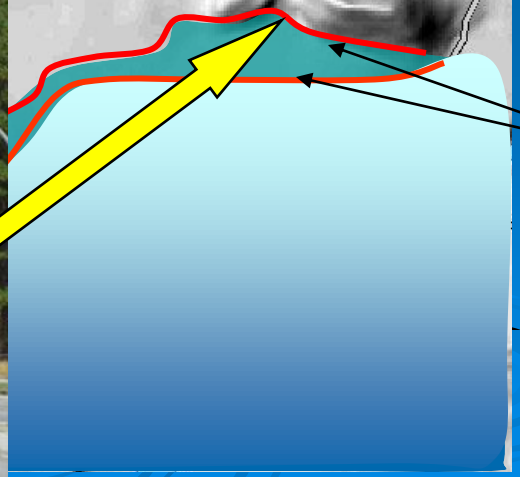
Component of Process	Important area for process
Infiltration, Percolation & Recharge	Areas with soils of high infiltration capacity and permeable surficial deposits





Movement of sub-surface water – vertical and lateral flow



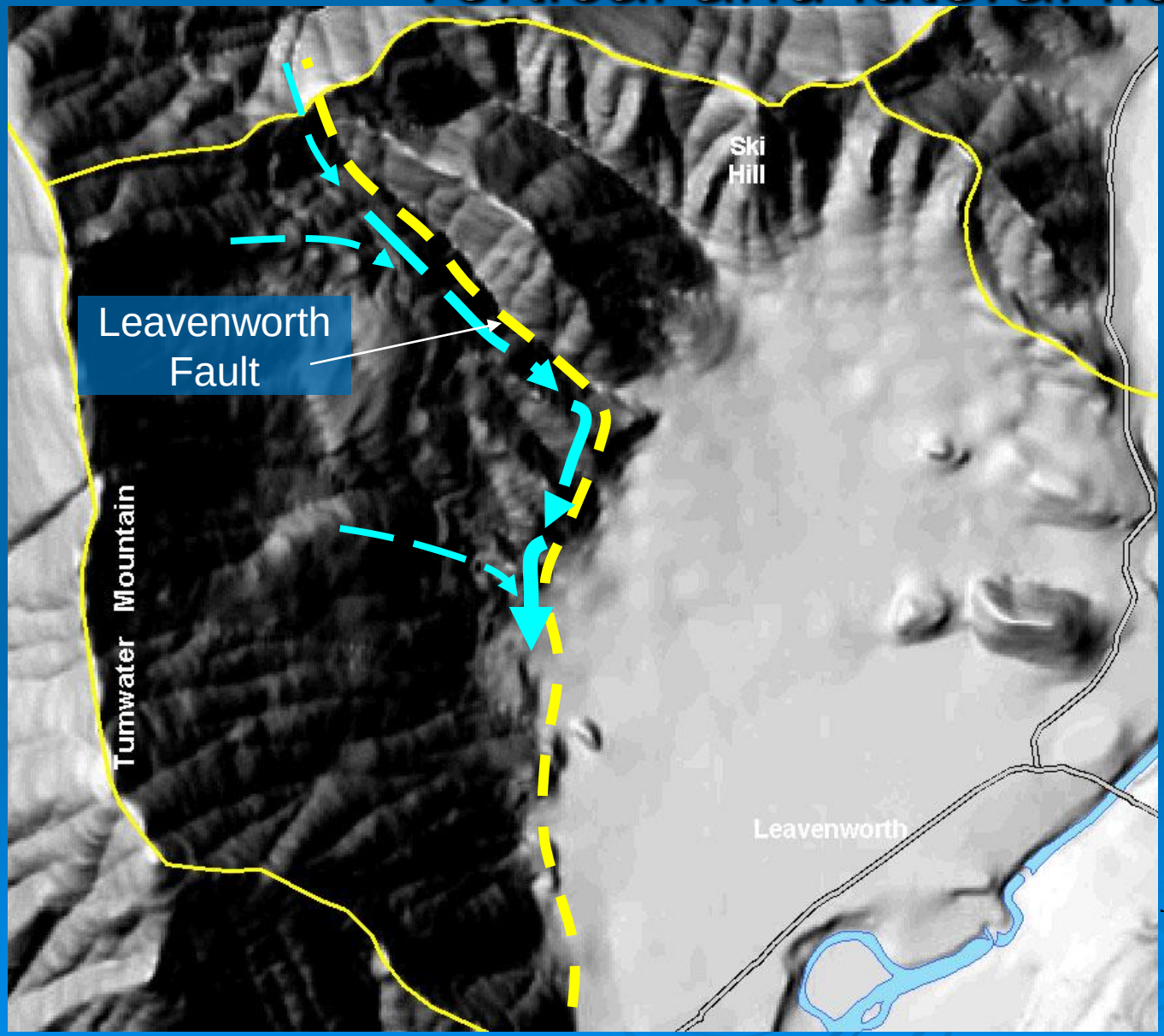


Leavenworth Fault – represents a major shear zone

Glacier advances

General Location of Moraines

Movement of sub-surface water – vertical and lateral flow

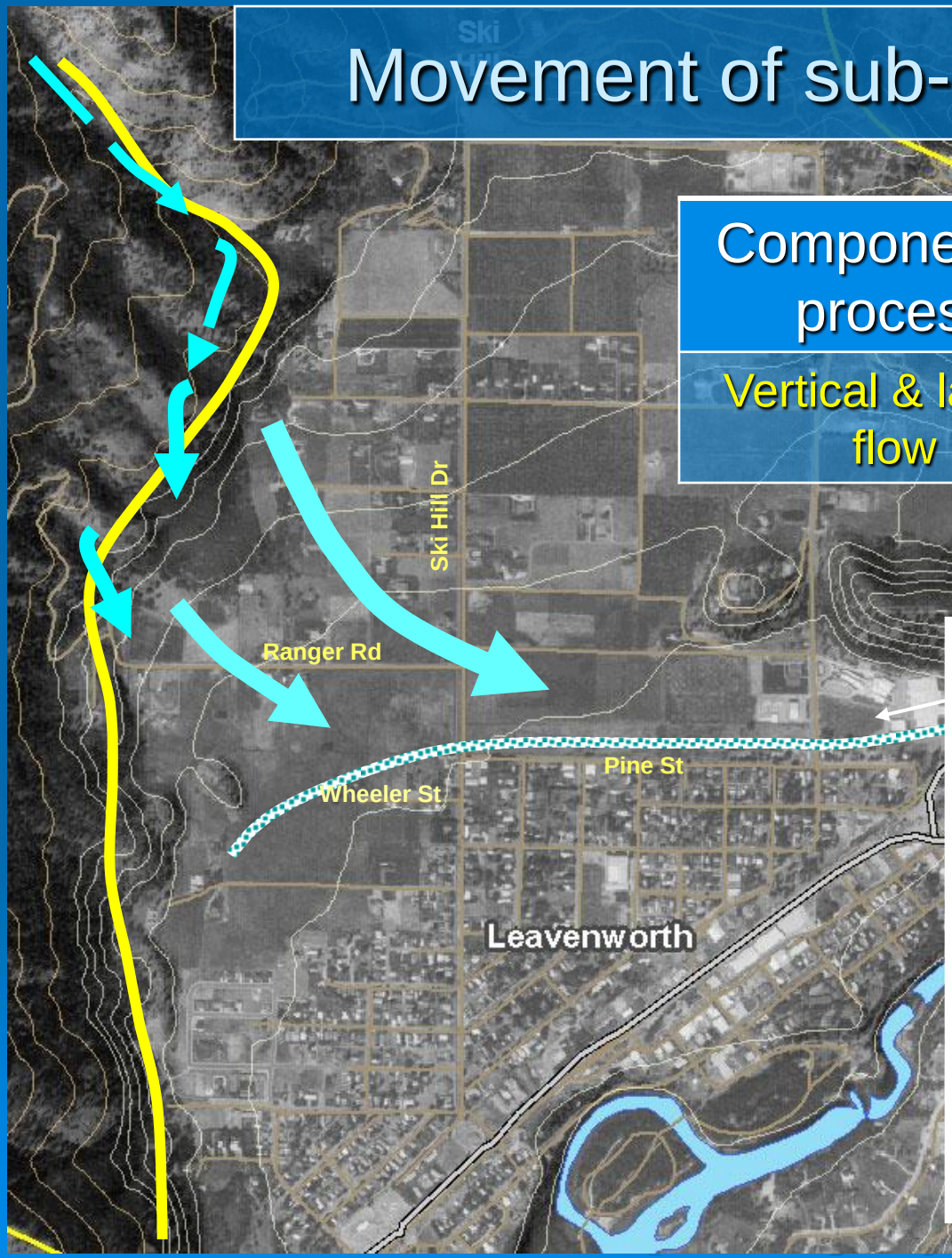


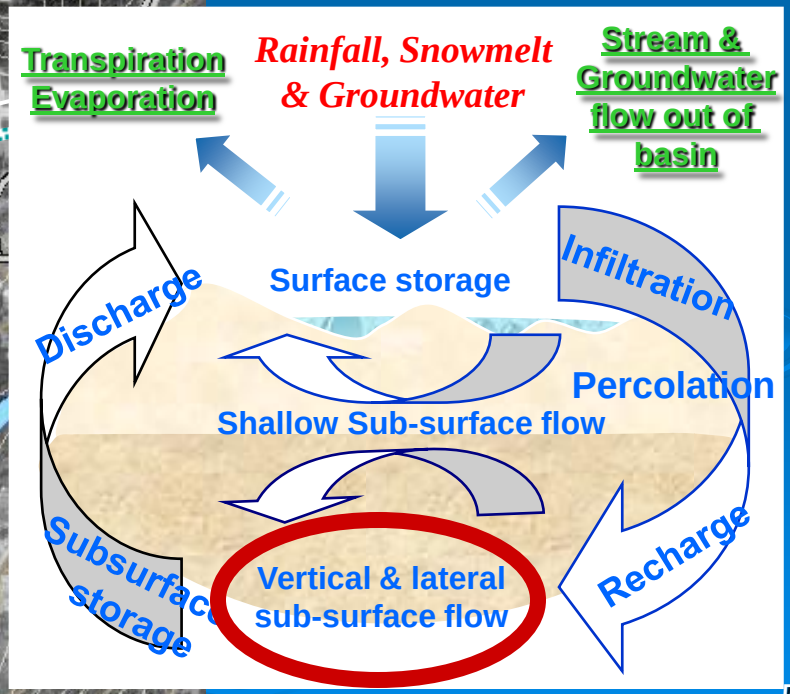
The fault acts like a "culvert" and collects groundwater from several subbasins

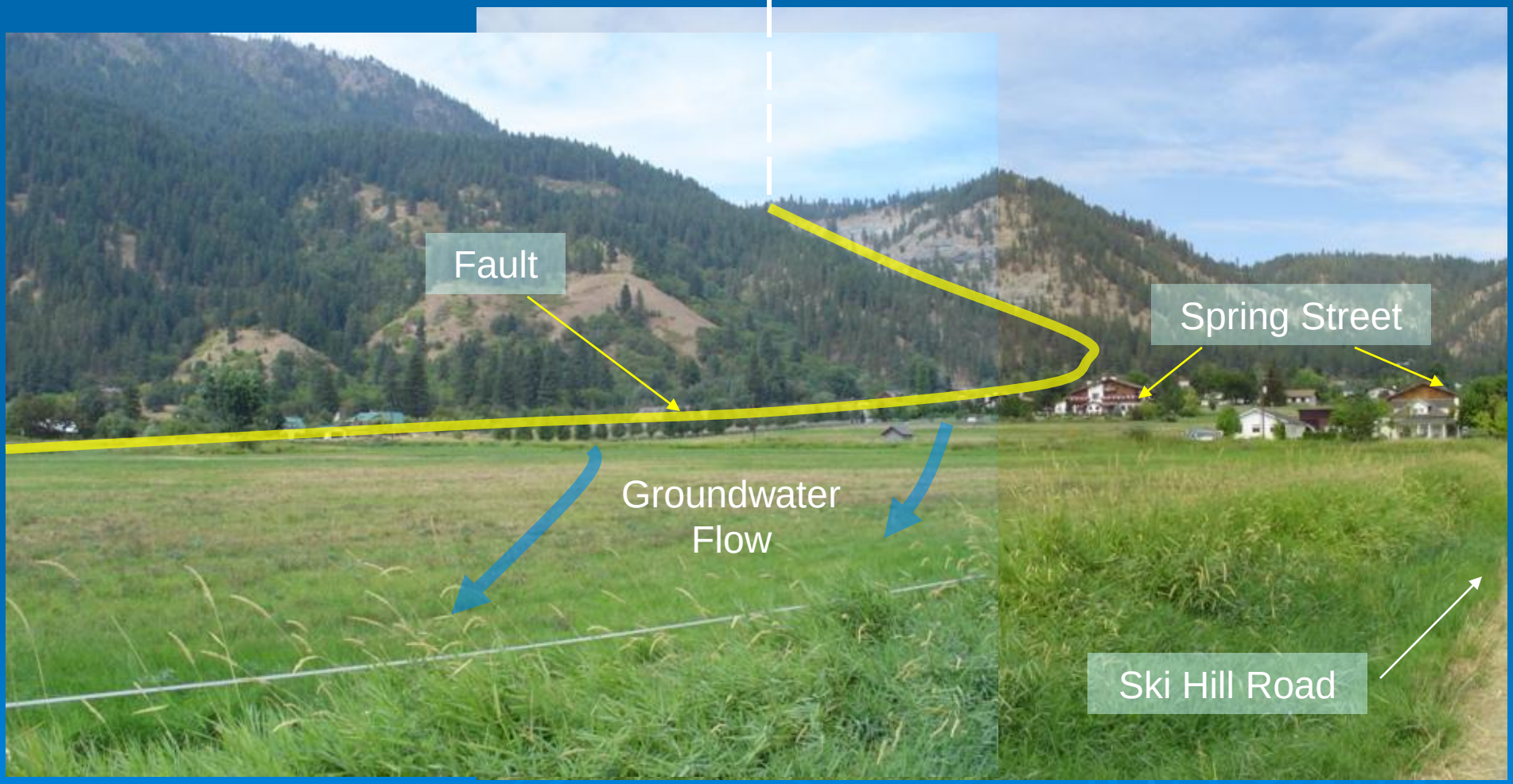
Increases water to lower basin

Movement of sub-surface water

Component of process	Important areas for process
Vertical & lateral flow	Determined locally

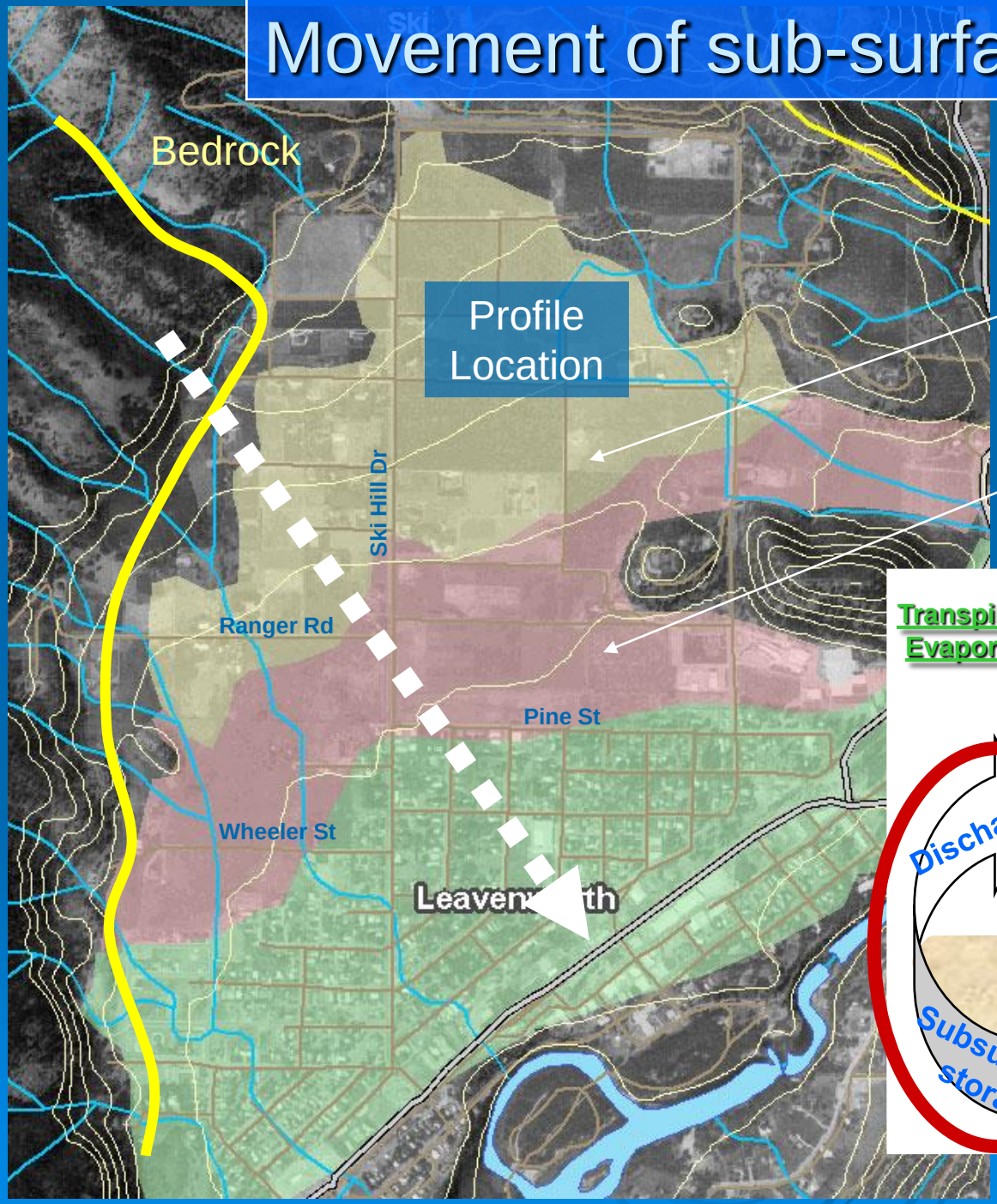






View Northwest from Ski Hill Road Towards Tumwater Mnt.

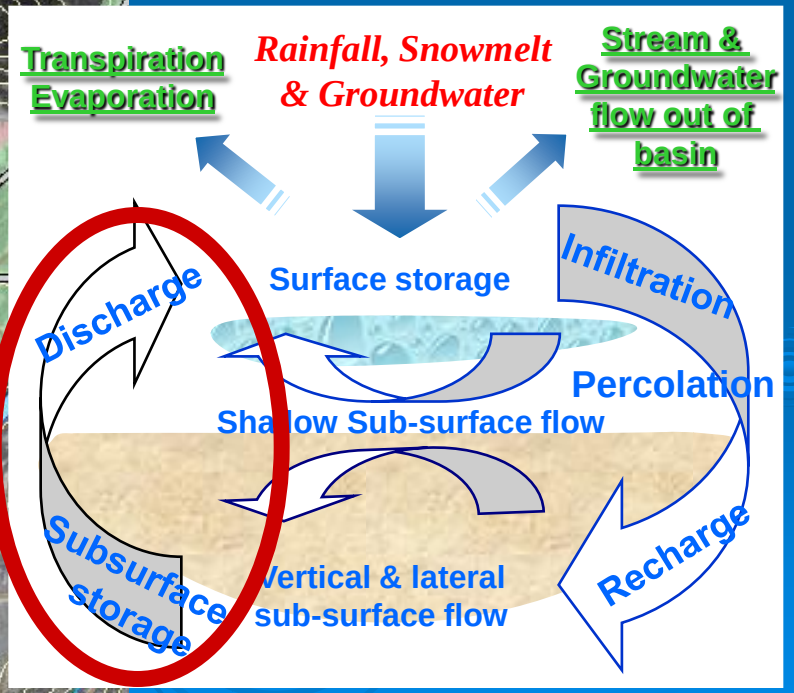
Movement of sub-surface water



Surficial Geology

Older Alluvium – storage

Older Alluvium – discharge



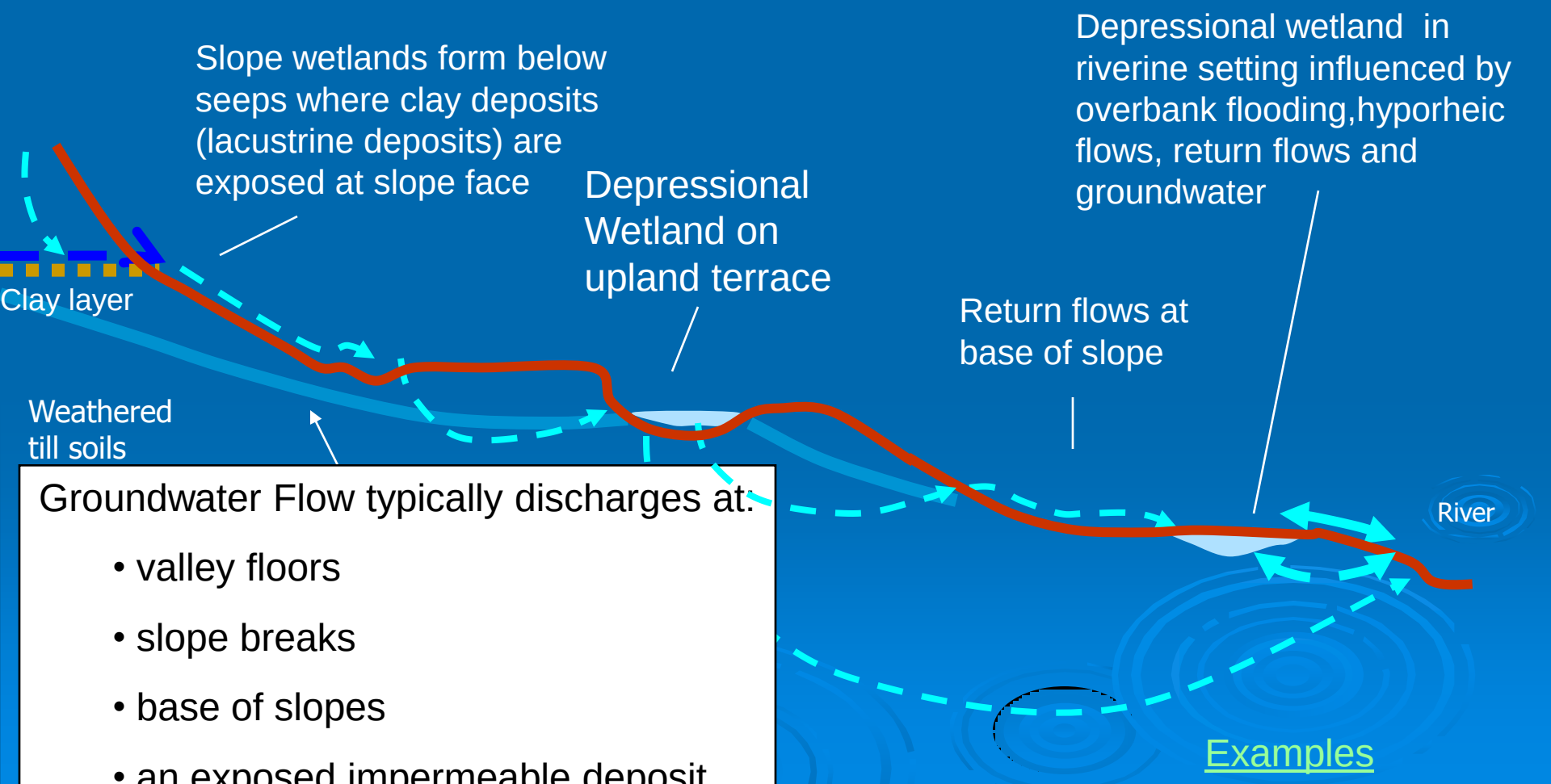
Understanding Glacial Deposts

Glacial meltwater eventually flows out the drainage of the present day Chehalis
"recessional outwash" which is not compacted

Geologic layers

- Recess Outwash
- Lake Deposits
- Till
- Advance Outwash
- Previous Glacial Deposit

Where Water Typically Surfaces



Groundwater Flow typically discharges at:

- valley floors
- slope breaks
- base of slopes
- an exposed impermeable deposit

Examples

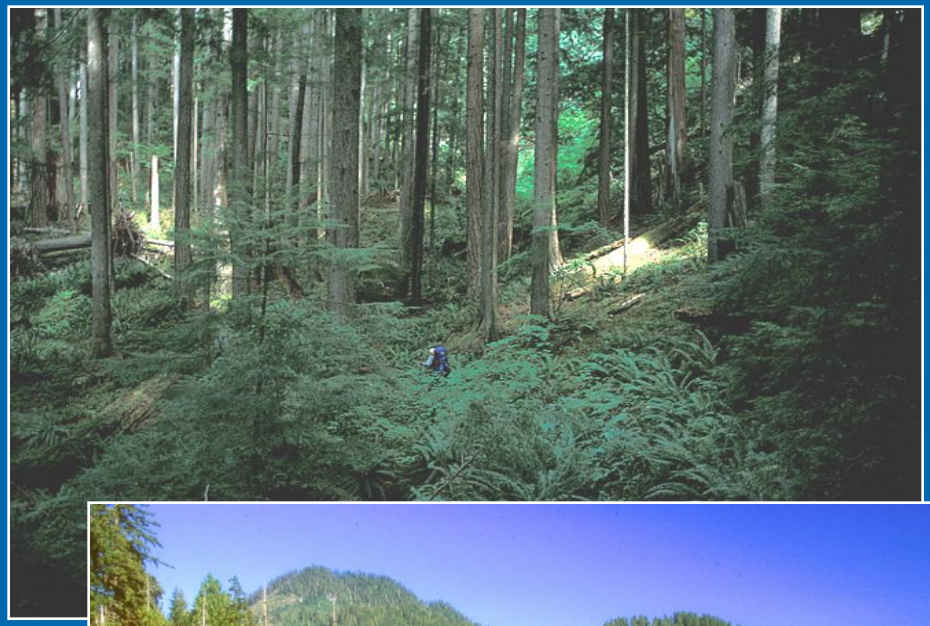
Example of Return Flow

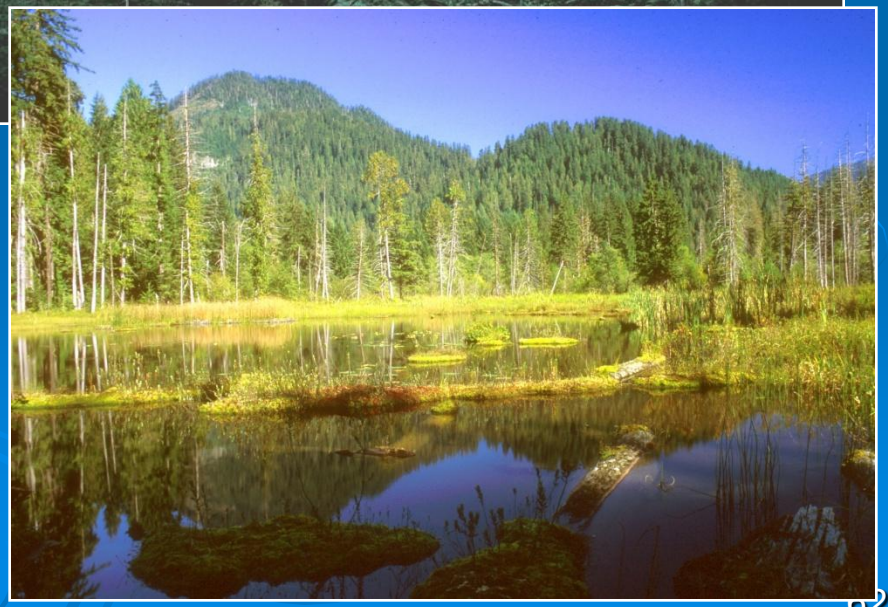
Return Flow at the base of a slope in rural setting

Under natural conditions subsurface flows predominate in the Pacific Northwest

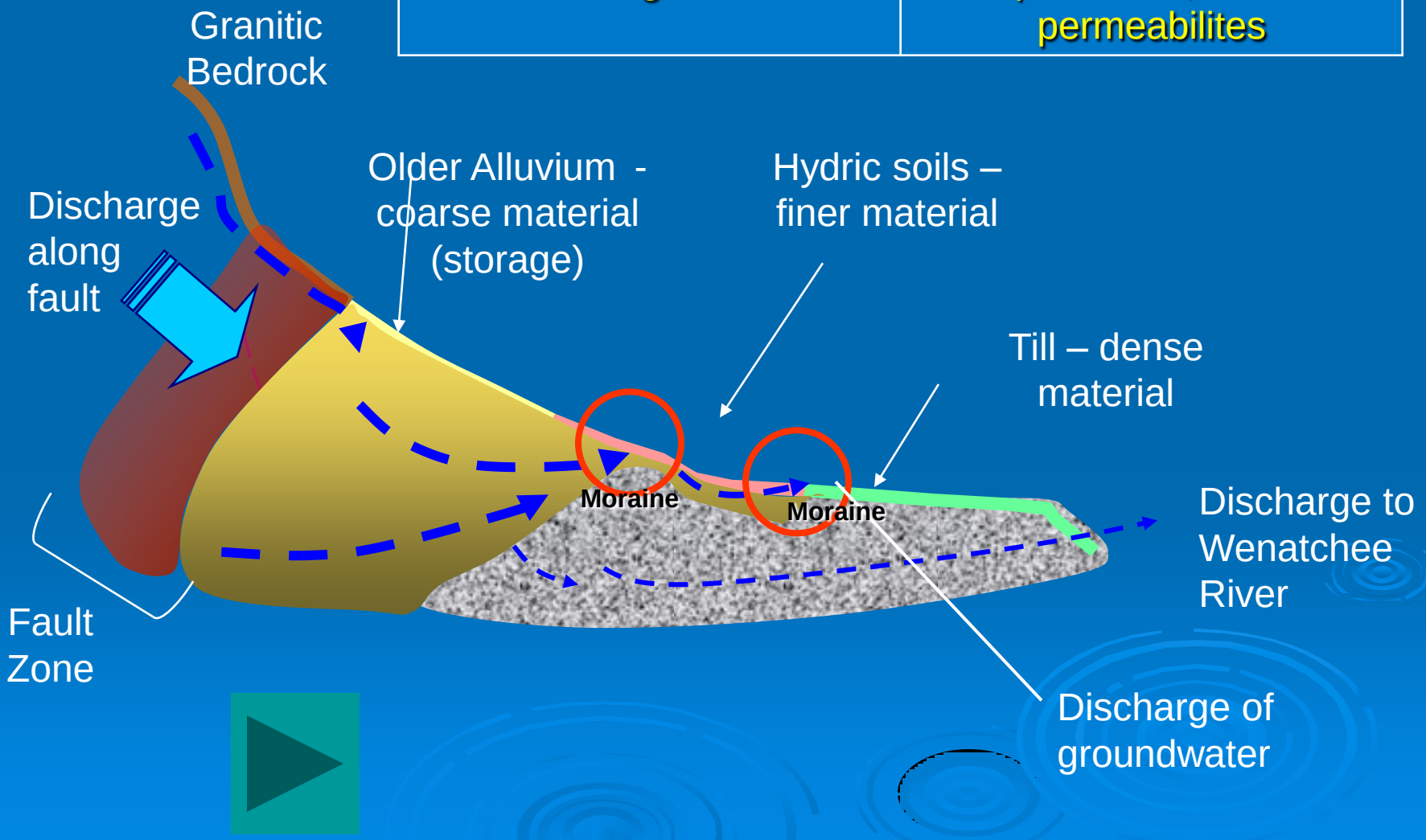
"In most humid regions, infiltration capacities are high because vegetation protects the soil from rain-packing and dispersal, and because the supply of humus and the activity of microfauna create an open soil structure."

Dunne & Leopold 1978





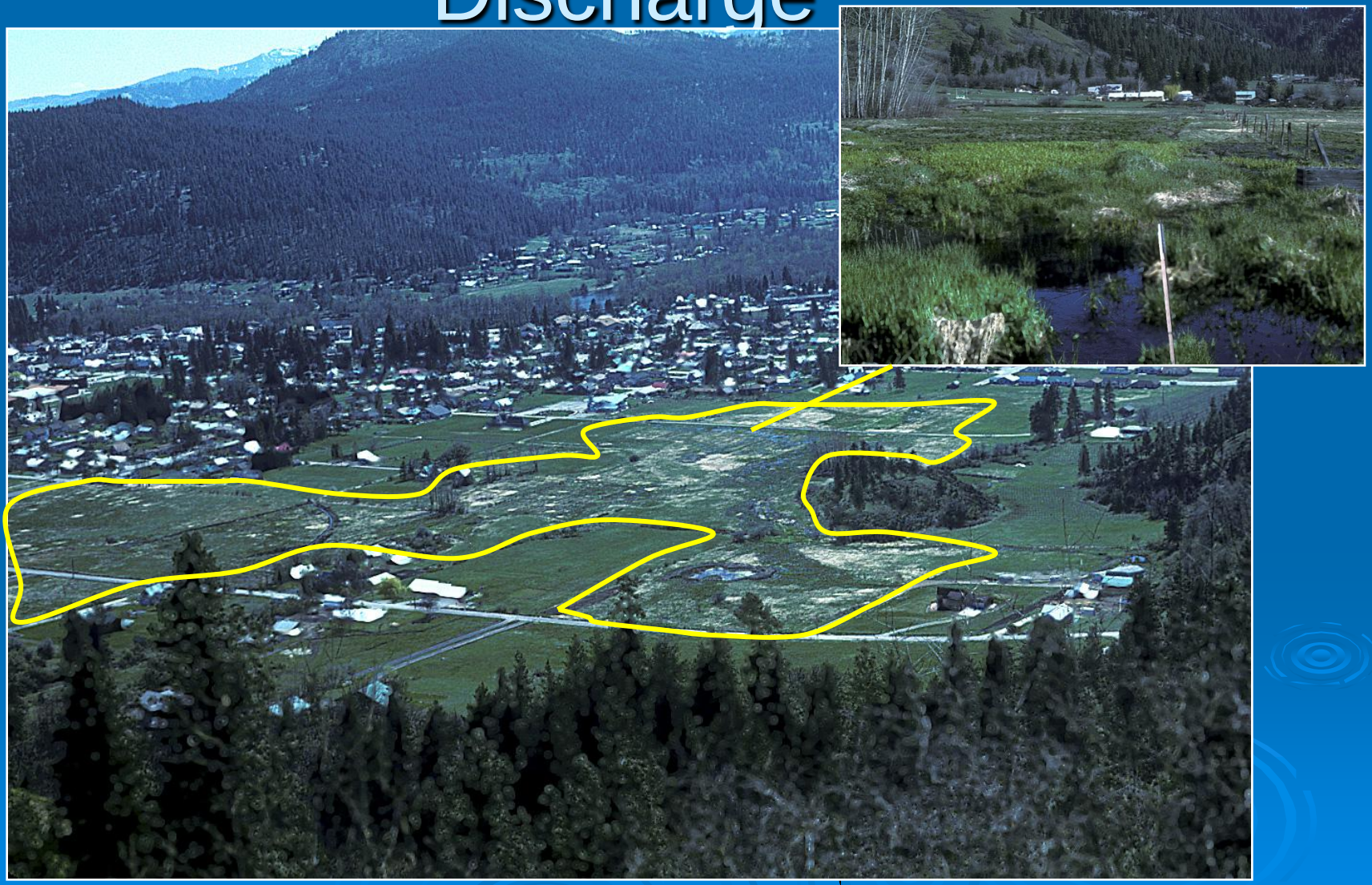
Component of process	Important areas for process
Subsurface storage	Permeable deposits
Discharge areas	Slope breaks, different permeabilites



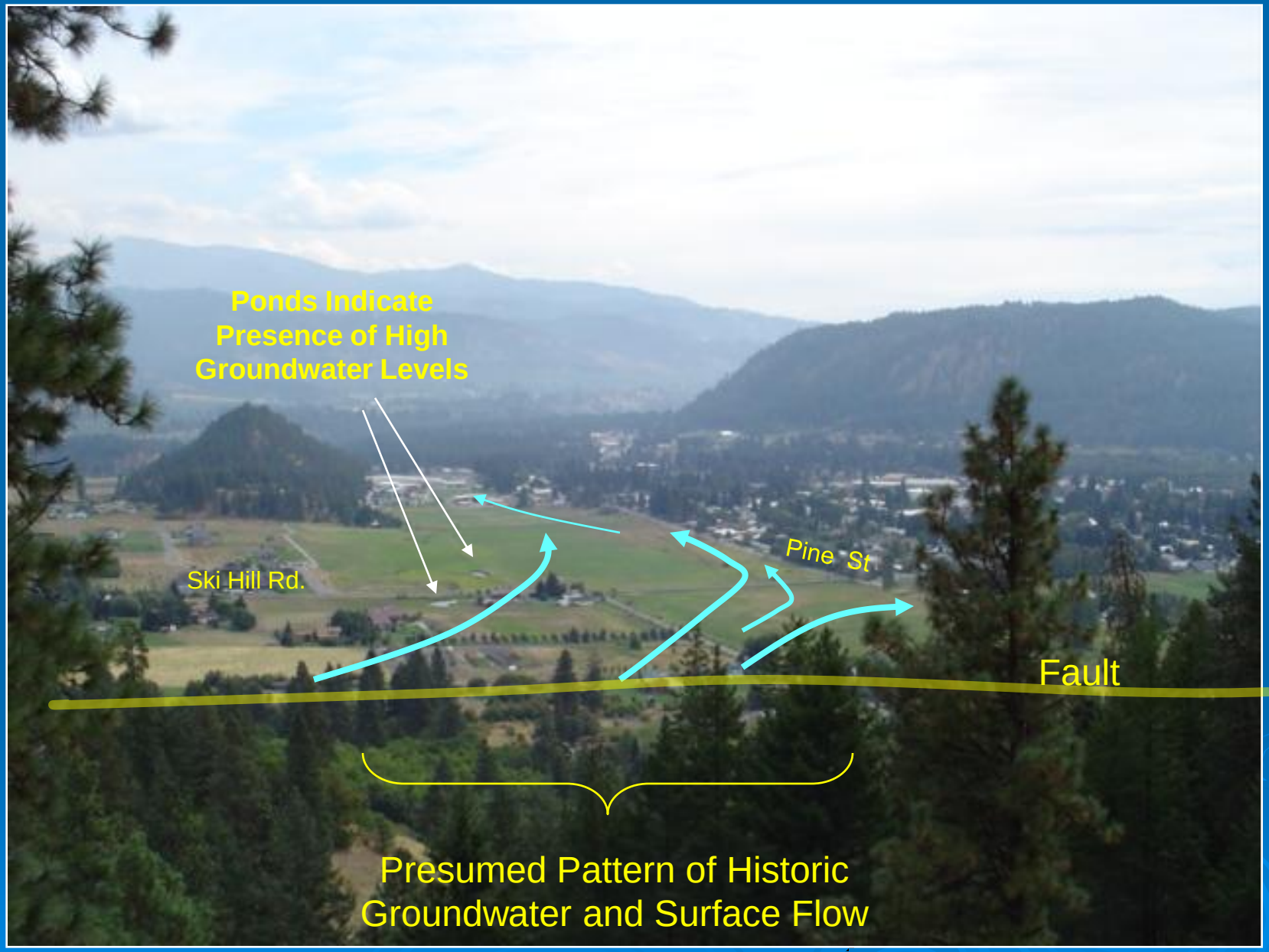
Upper Ski Hill – Area of Older Alluvium

View East Towards Chumstick River Valley

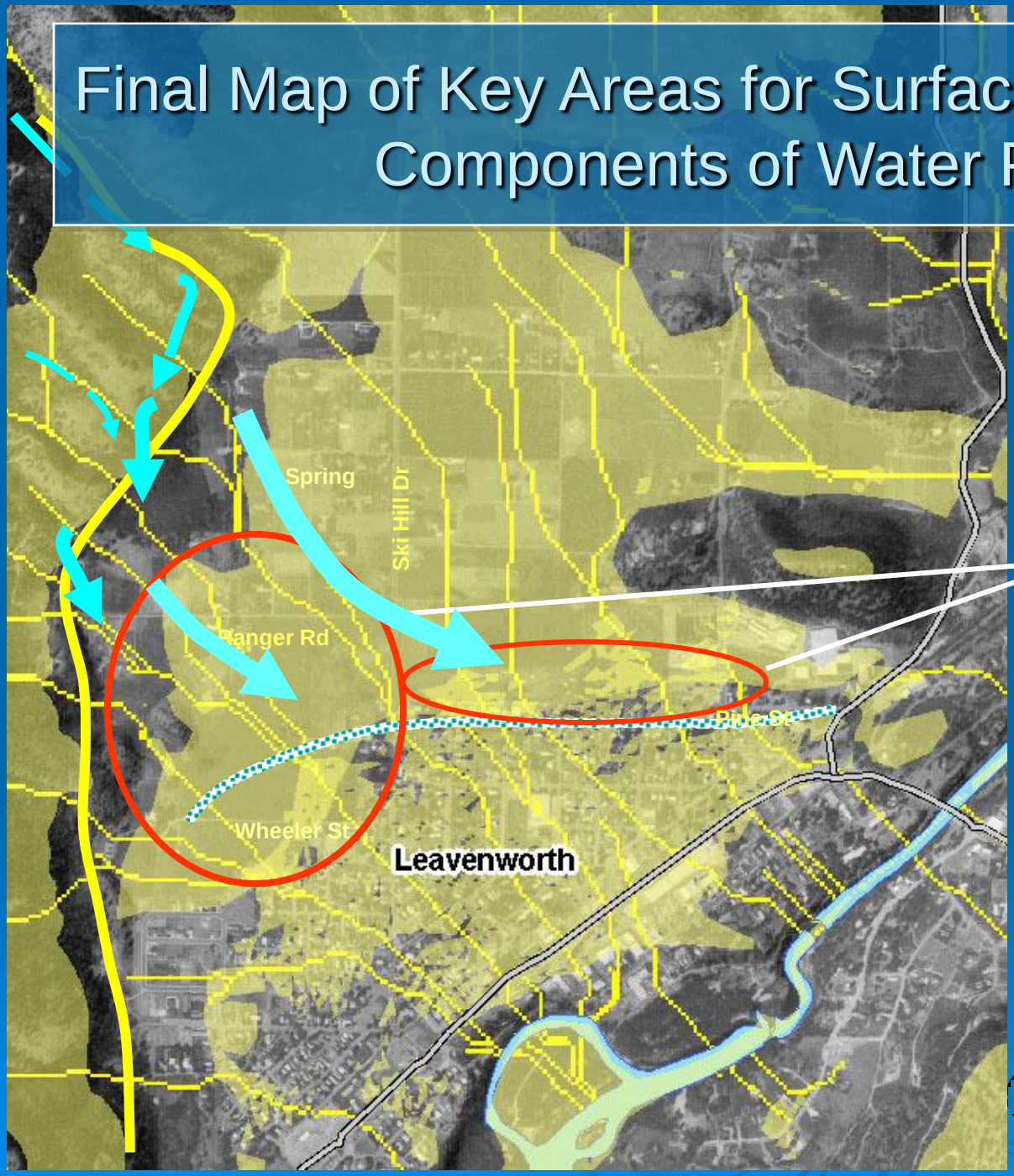
Area of Greater Groundwater Discharge



View SE Towards Ranger & Wheeler Rd & Town of Leavenworth


Ponds Indicate
Presence of High
Groundwater Levels
Ski Hill Rd.
Pine St
Fault
Presumed Pattern of Historic
Groundwater and Surface Flow

Final Map of Key Areas for Surface and Sub-surface Components of Water Process

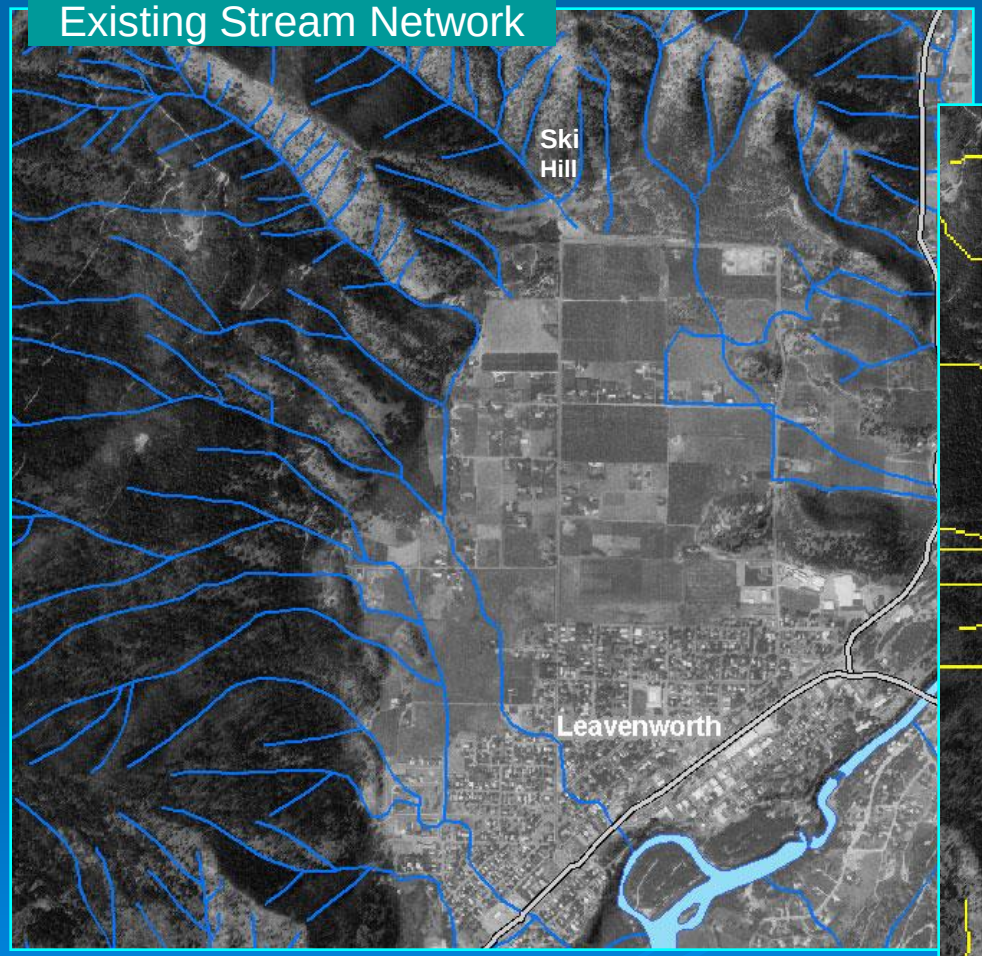


Probable areas of highest discharge

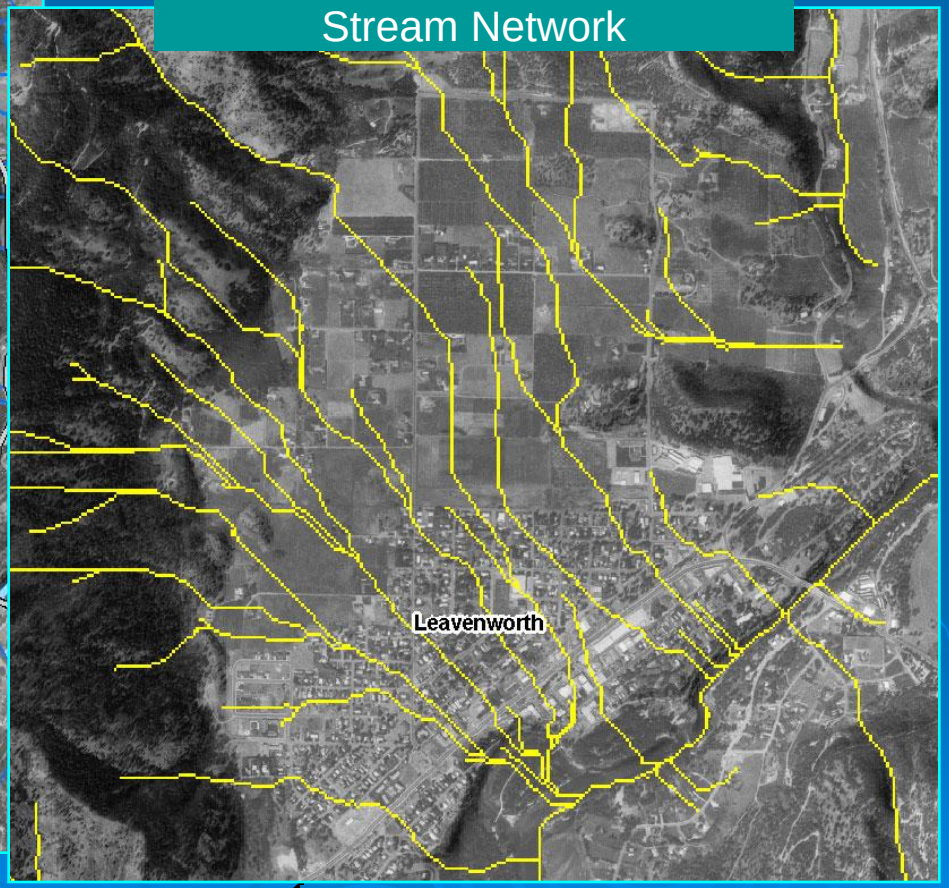
Step 4 – Identify and map types of Impairments

Indicators of Impairment to Surface Water Runoff
Loss of Stream Floodplain:

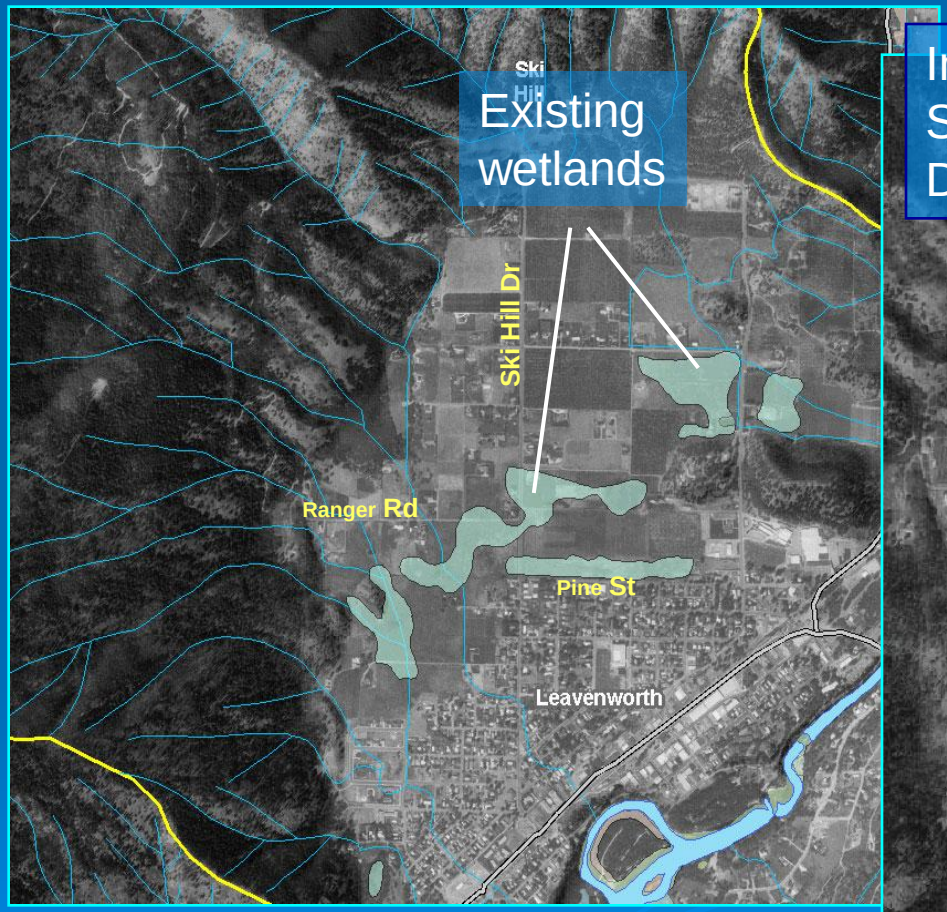
Existing Stream Network

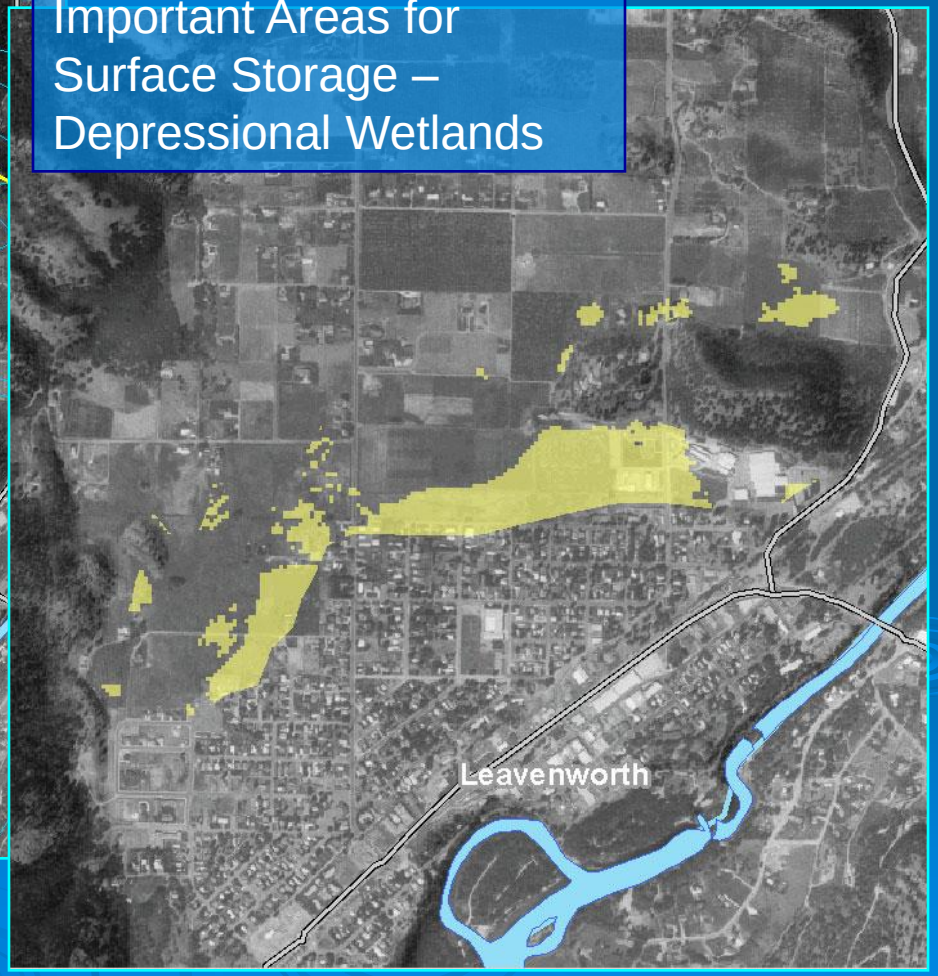


Important Areas for Surface Storage – Probable Historic Stream Network



Indicators of Impairment to Surface Water Runoff
Loss of Surface Storage:



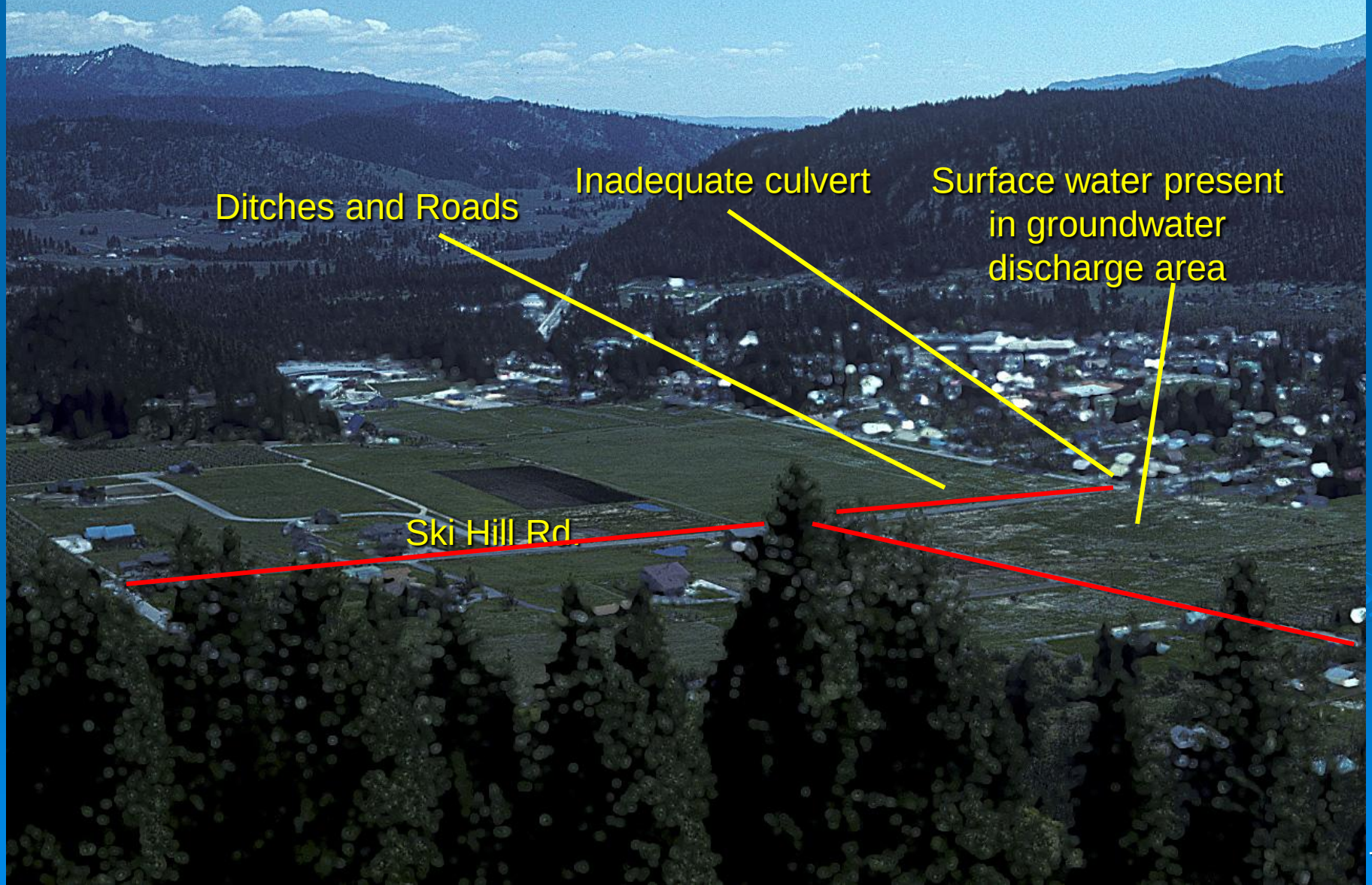


Impairment of Groundwater Flows

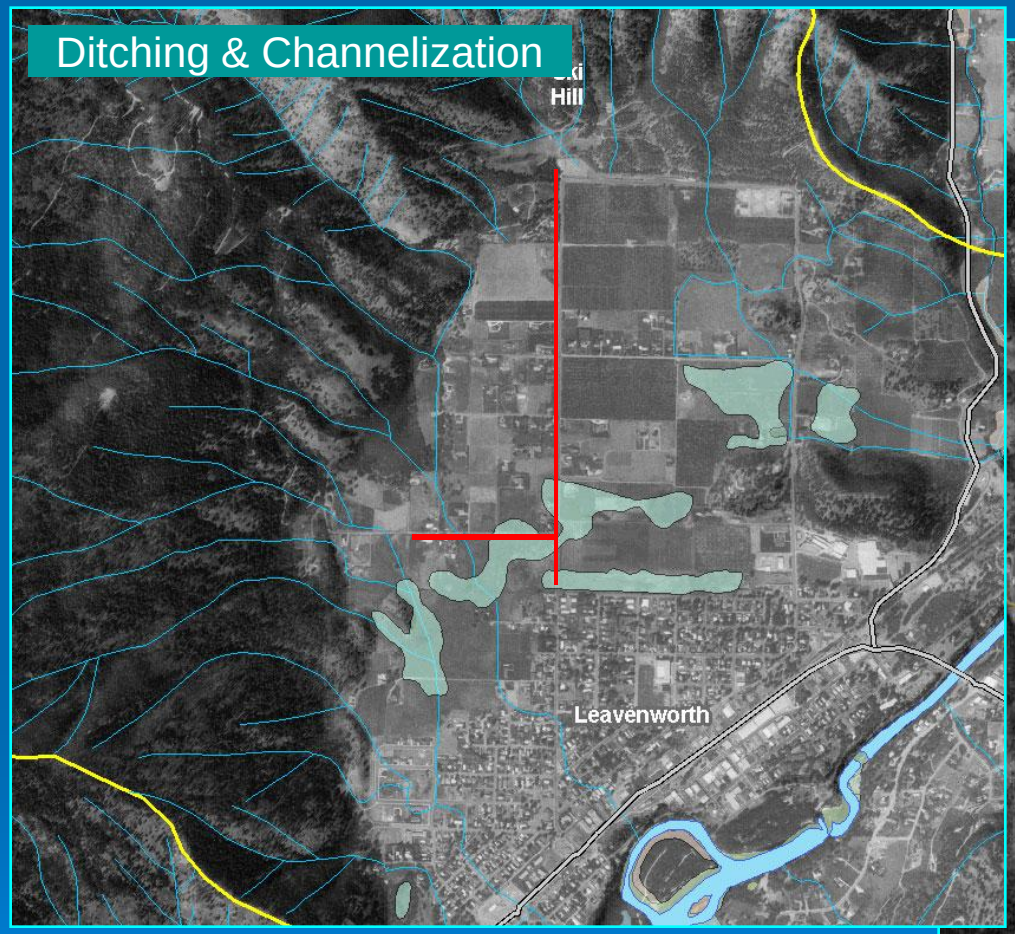
Ski Hill
Road Ditch

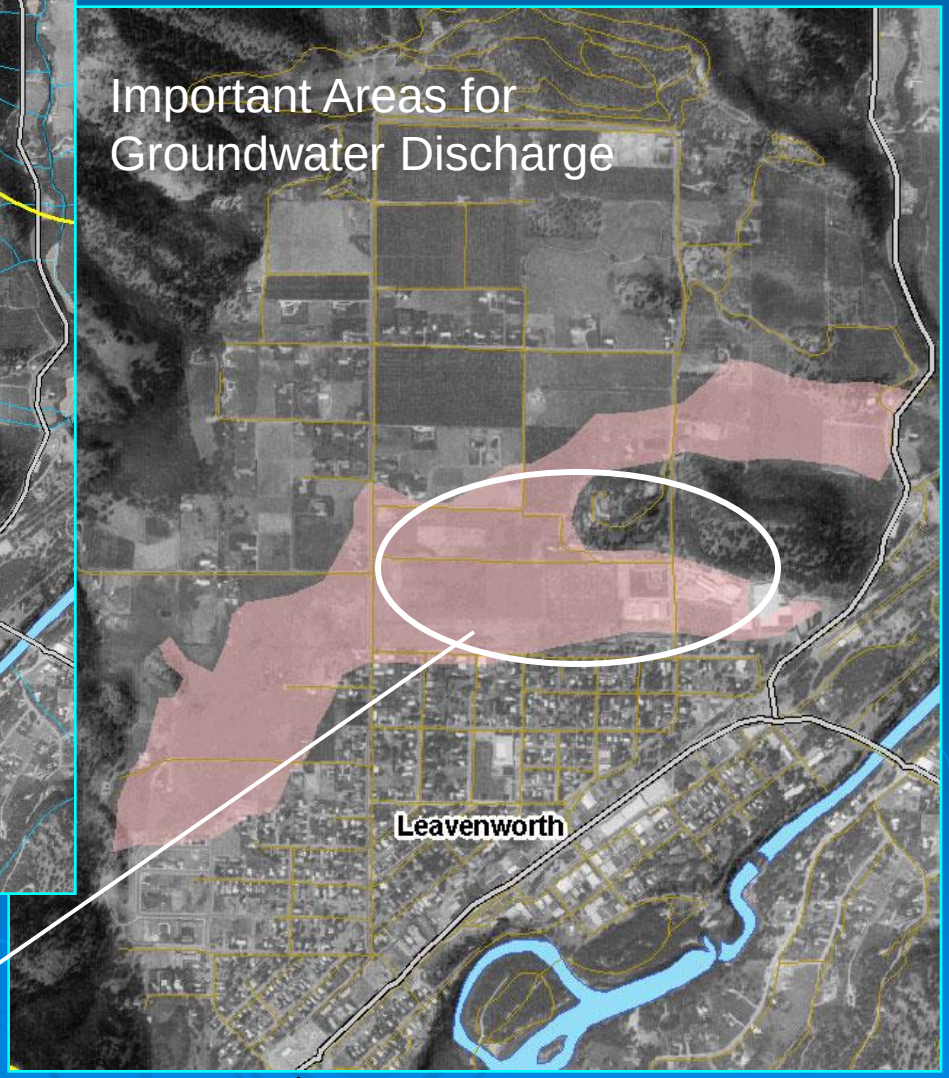
Northeast Corner of Intersection of Pine and Ski Hill Road

Impairment of Groundwater Movement and Surface Runoff

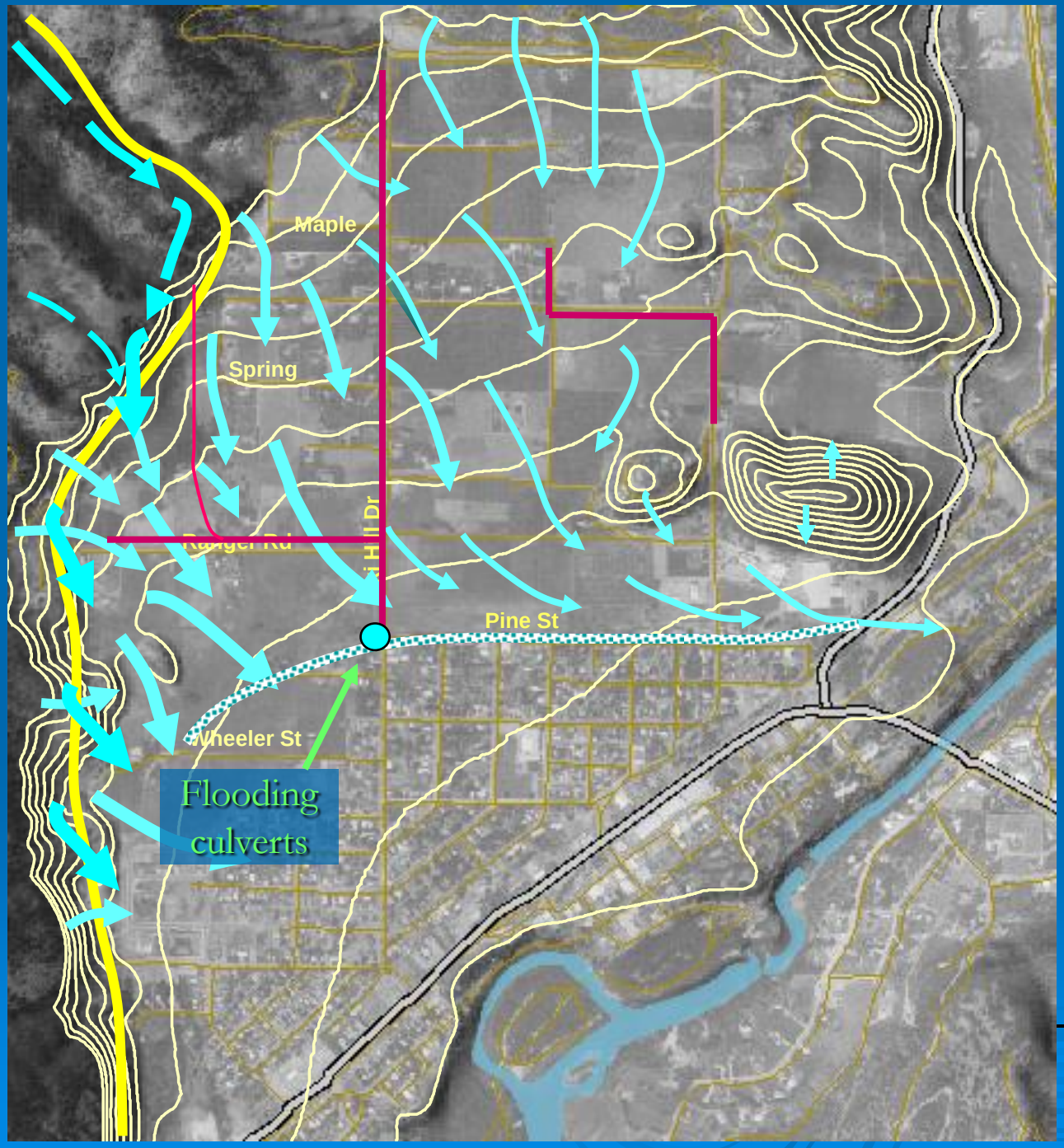


Indicators of Impairment to Groundwater Movement
Decrease in Groundwater Discharge to Aquatic Resources





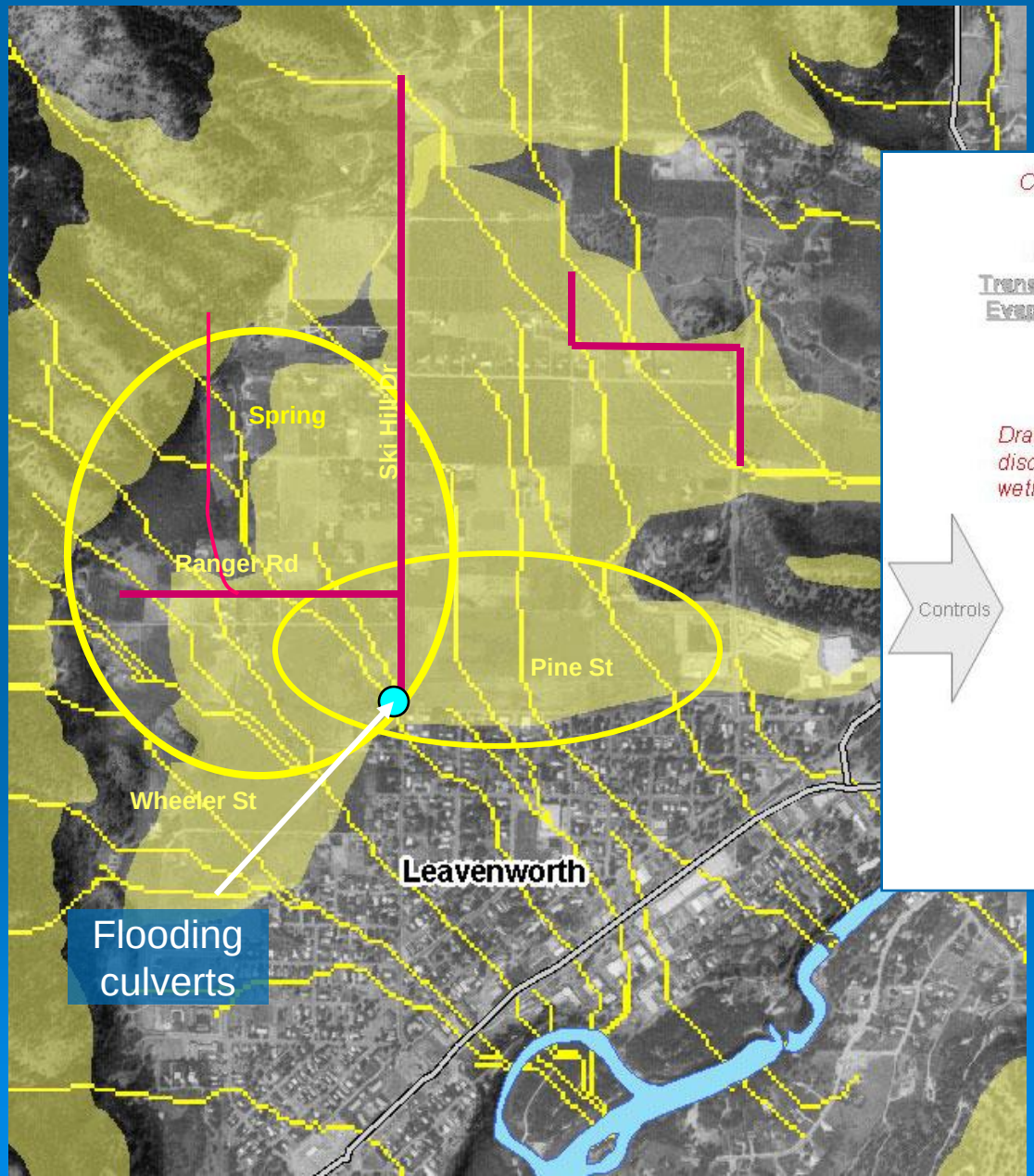
Historic groundwater flow patterns altered by ditches reducing natural discharge to east of Ski Hill Road

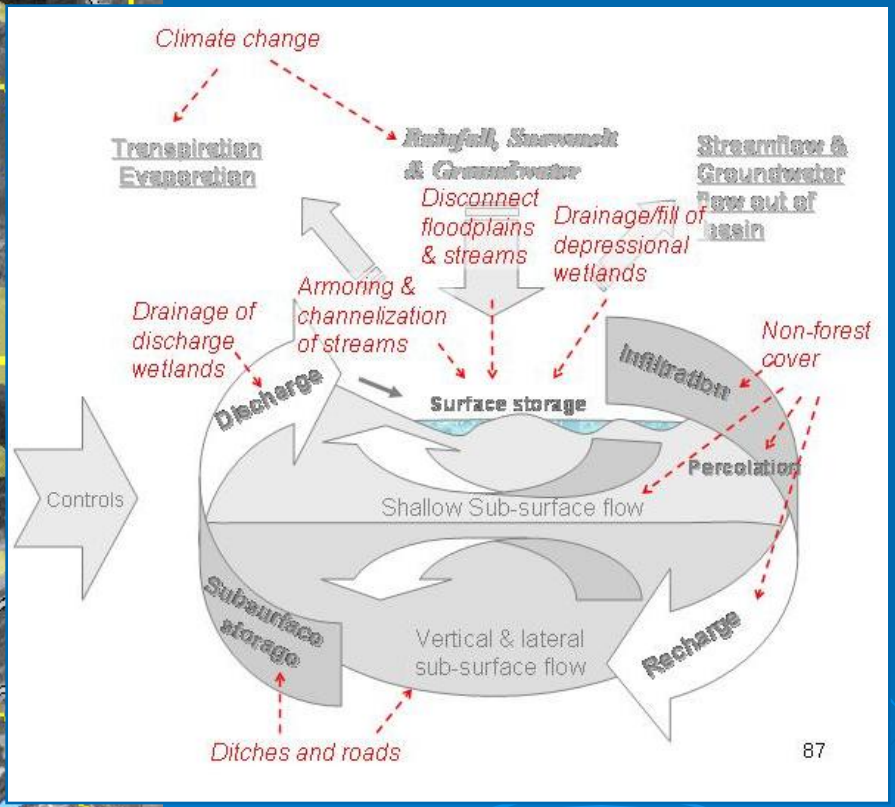


Analyzing Changes to Water Flows

Ditches intercept groundwater and bring it to surface. This increases the flooding problems.

Final Impairment Map

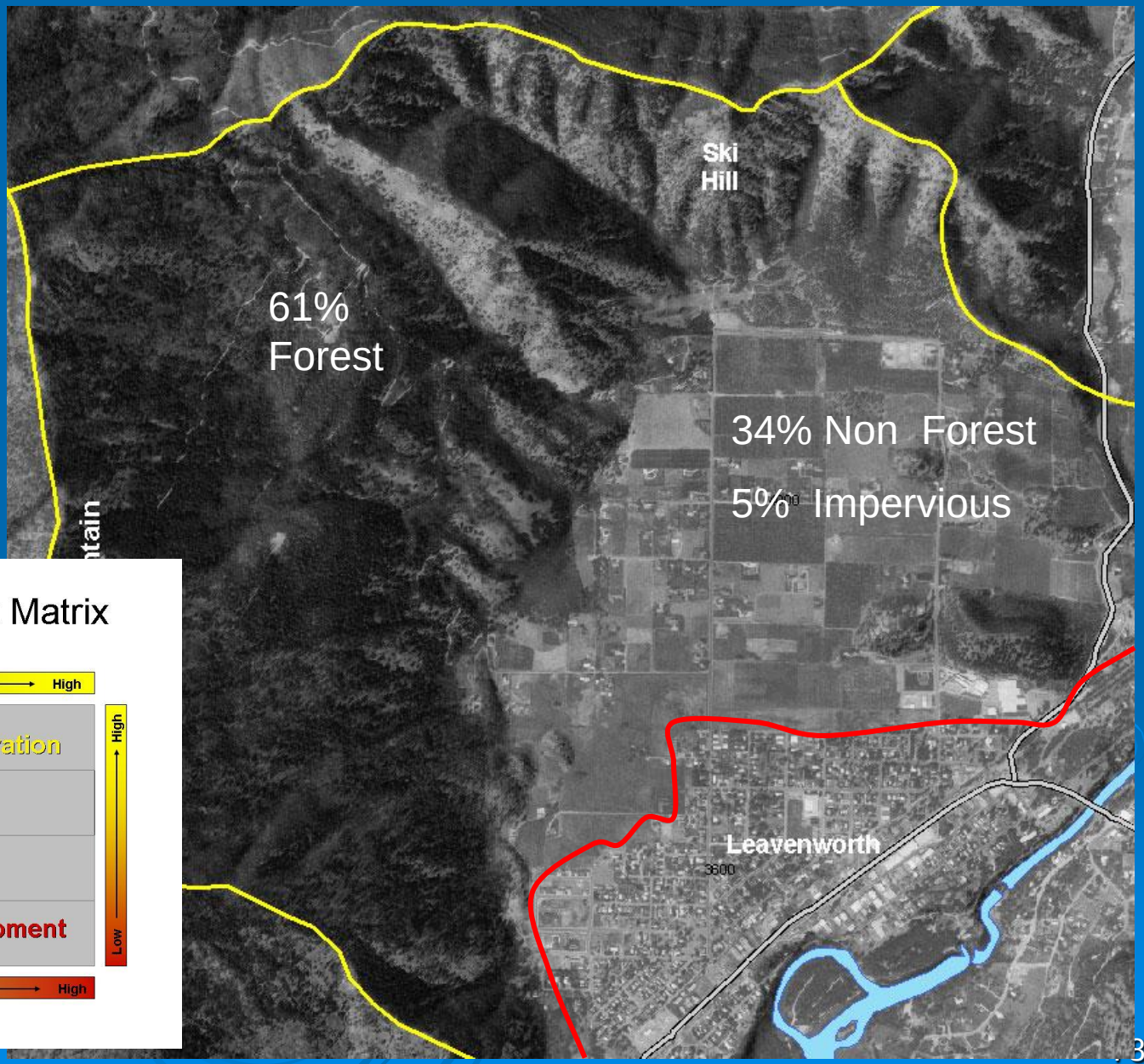


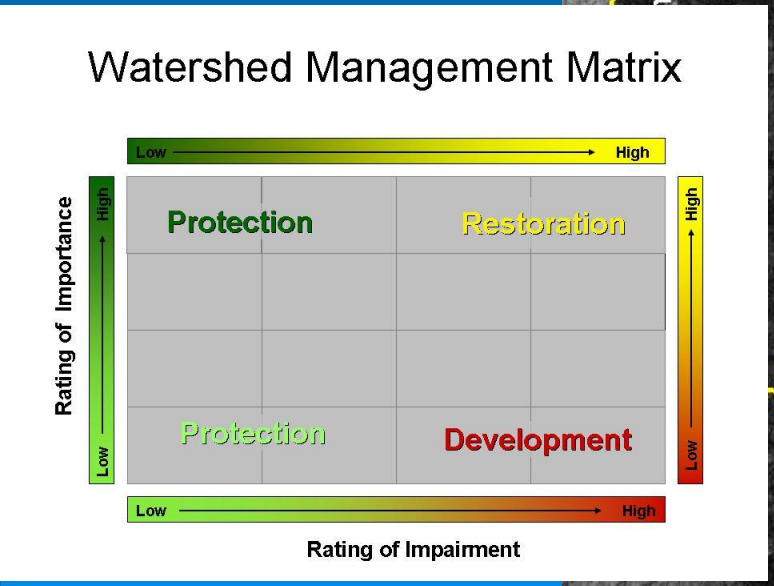


Step 5 – Locate Areas for Protection & Restoration

Group Activity
Develop Restoration and Protection Plan Based on Characterization Results

Evaluate Restoration & Protection Opportunities



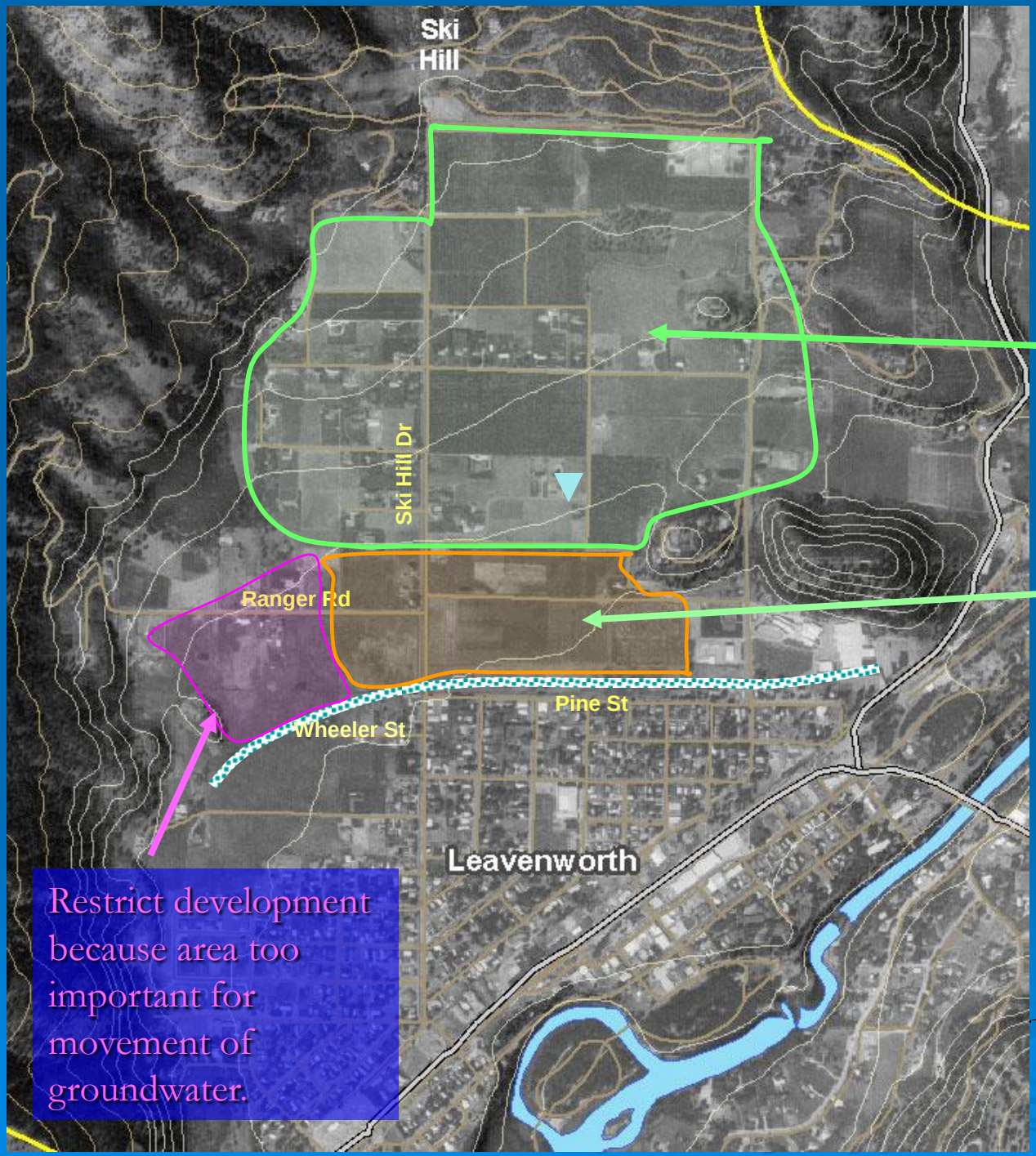


To Address the Flooding Problem, Answer the Following Questions

- Which areas should be protected (i.e. critical to maintaining processes)
- Which areas should be restored & why?
- What type of restoration plan would you implement?
- Where would you site future development (type, configuration, design)?
- What type of development measures/standards would you require?

Synthesis Table

Reach , Site or Management Unit Name	Rating of Processes and Functions (unimpaired condtions)	Rating of Impairment (existing conditions)	Recommended Solutions
	Processes – (rate high, medium, or low) Rating for Delivery is _____ Rationale_____ Rating for Surface Storage is _____ Rationale_____ Rating for Sub-surface movement is_____ Rationale_____ Rating for Discharge is _____ Rationale_____	Processess – (rate high, medium, or low) Rating for Delivery is _____ Rationale_____ Rating for Surface Storage is _____ Rationale_____ Rating for Sub-surface movement is_____ Rationale_____ Rating for Discharge is _____ Rationale_____	Land Use Restoration-Protection measures



Planning for Future Development

Develop LID standards to reduce surfacing of groundwater.

Restore wetlands as mitigation for wetland impacts elsewhere.

Develop transfer of development credits program for the areas where development is restricted.

Restrict development because area too important for movement of groundwater.

Lunch

Introduction to Modeling

Approaches to Modeling

- Logic model - Indicators (variables) are combined using logic statements (and, or, if…then)
- Mechanistic model - Indicators (variables) are combined in equations using mathematical operators
- Methods are a collection of models

Rapid Assessment Method

All rapid assessment methods:

- model a process of judgment by experts
- are NOT mathematical representations of actual environmental processes.

Limitation of Rapid Methods

Variables can only represent fixed structural characteristics of a wetland or landscape.

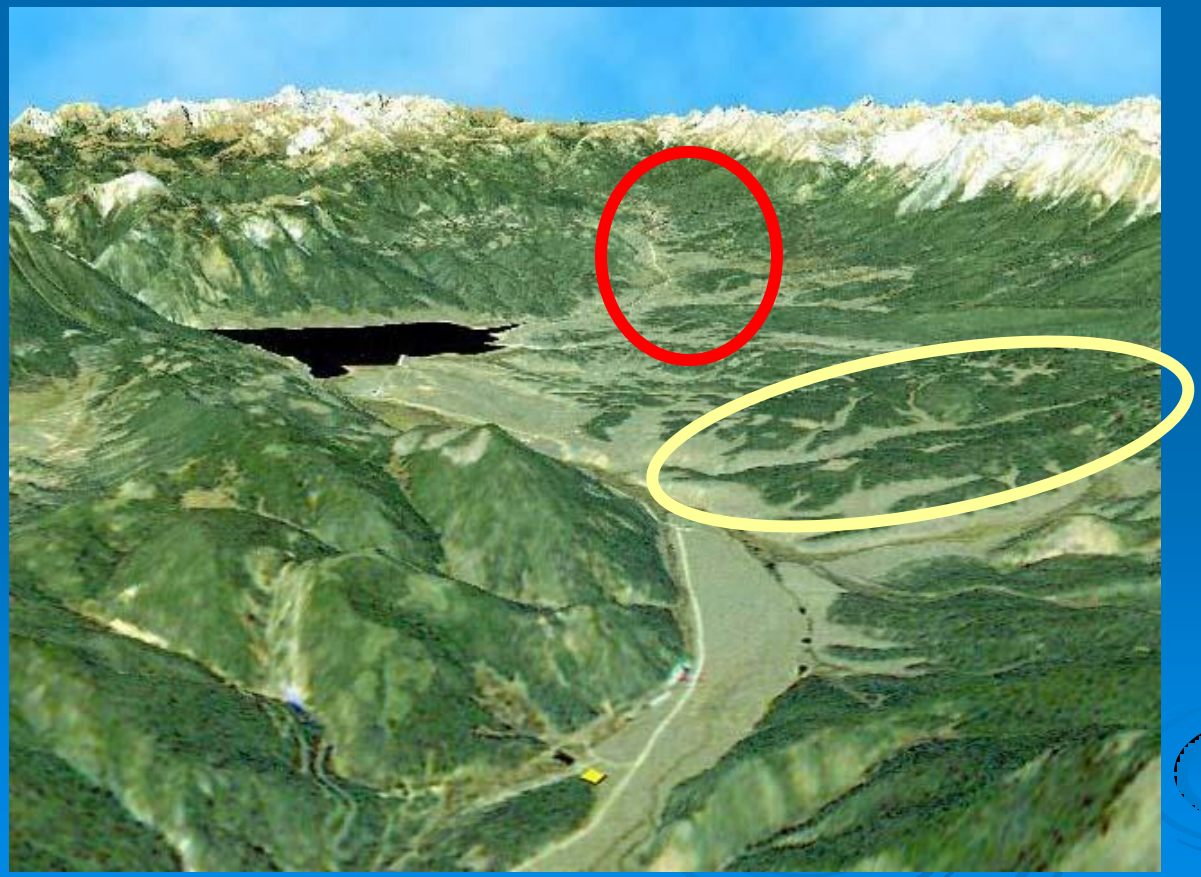
Rainfall
soil type
% forest cover

Not dynamic processes:

rates of flow, etc.

Process – Scoring Movement of Water in a Sub-basin

Score = Surface Water + Groundwater + Evapotranspiration

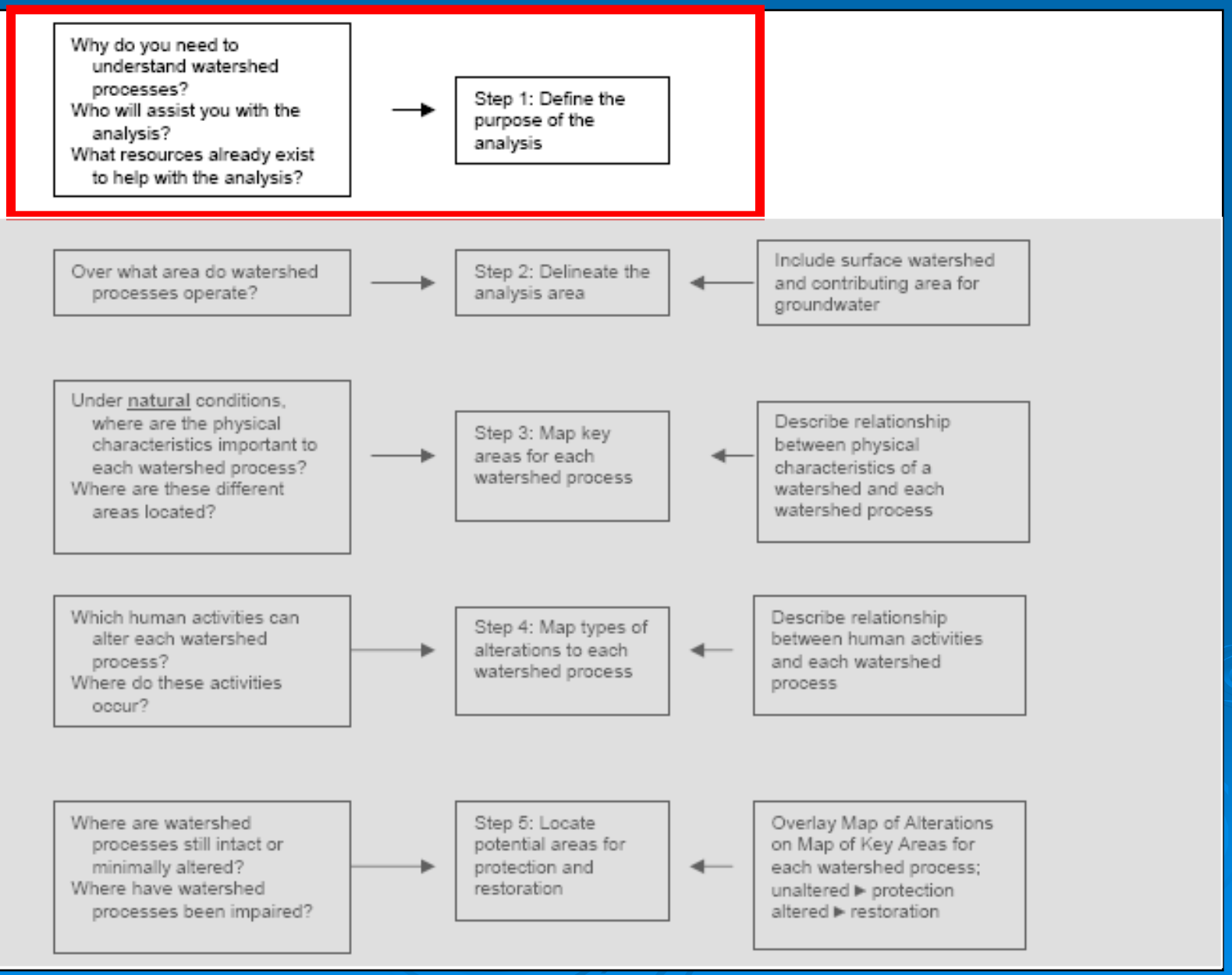


Purpose: Compare importance of sub-basins in the entire watershed and rank them.

Introduction to Modeling

Applying Characterization to Planning & Permitting in Clark County

Step 1 – Define the Purpose



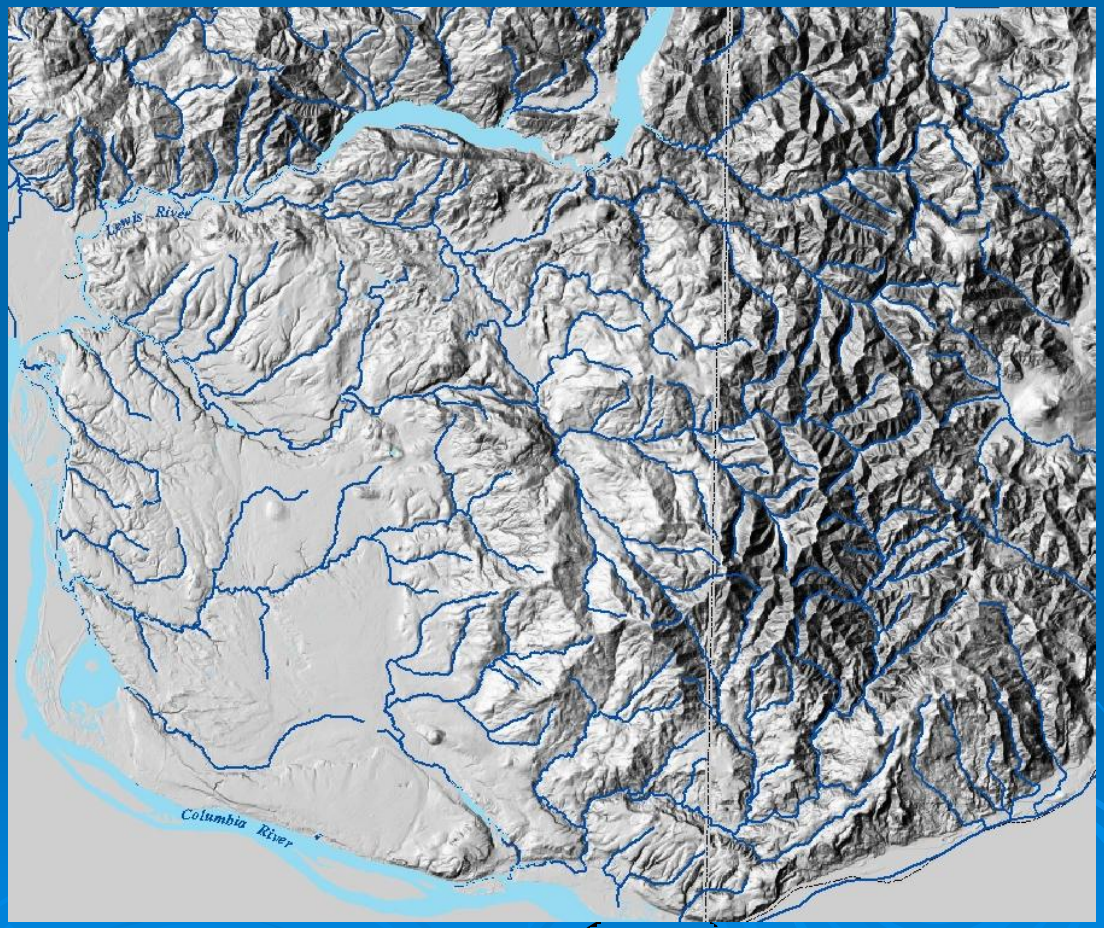
Purpose of Analysis – Develop County-wide Mitigation Plan

Mitigation Plan will help identify best areas for:

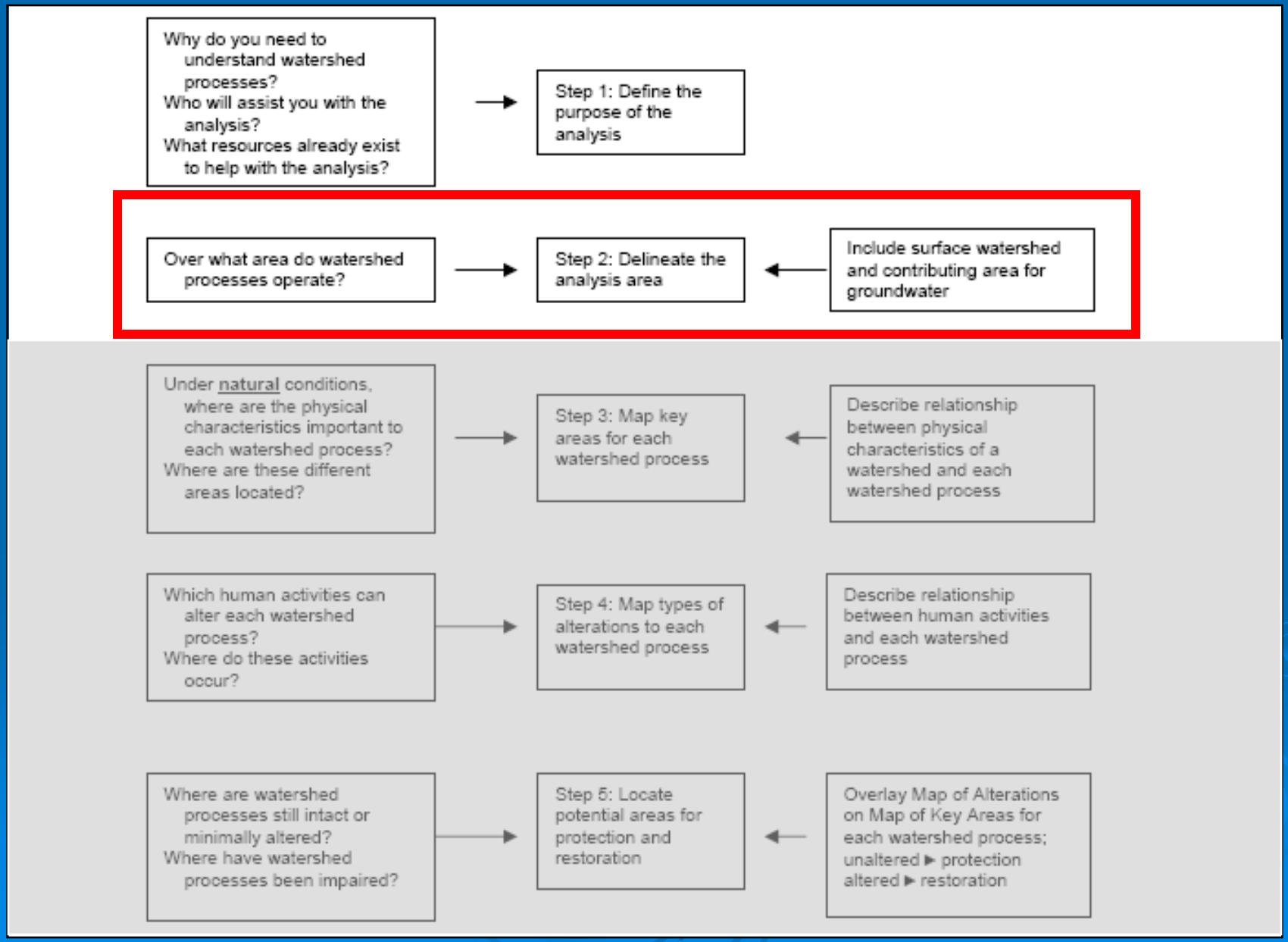
- Protection
- Restoration
- Mitigation Banks

This will assist in updating

CAO and SMP



Step 2 – Delineate Analysis Area



Establish Hydrogeologic Units

- Hydrogeologic units based on:
  - Geology
  - Groundwater and surface water flow patterns
  - Precipitation Type
  - Landform

Based on work by Bedford and Winter

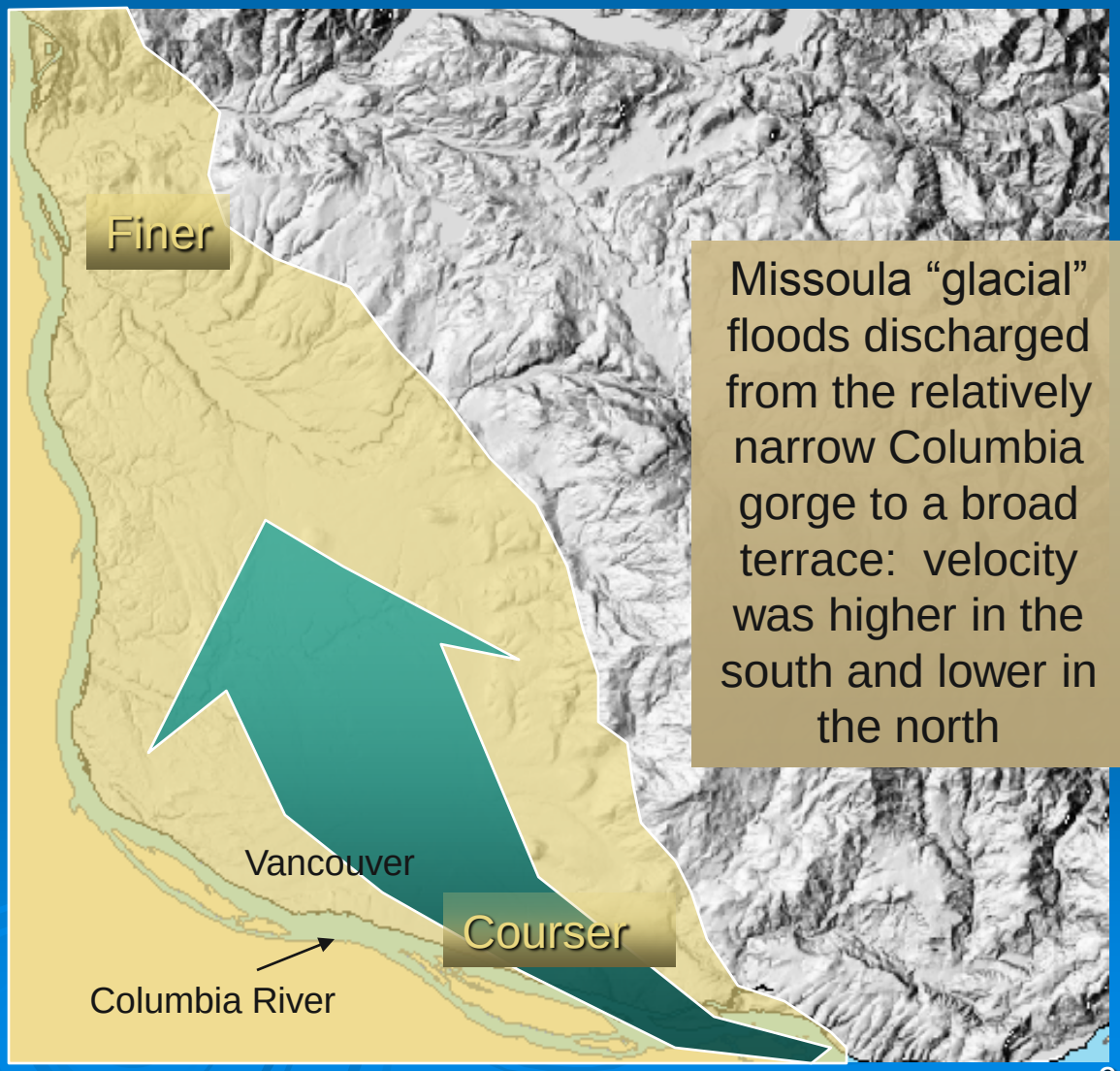
Collect Info to Understand Geology

Permeability of geologic deposits is the result of how water and ice “sorted” coarse to fine grain sediment.

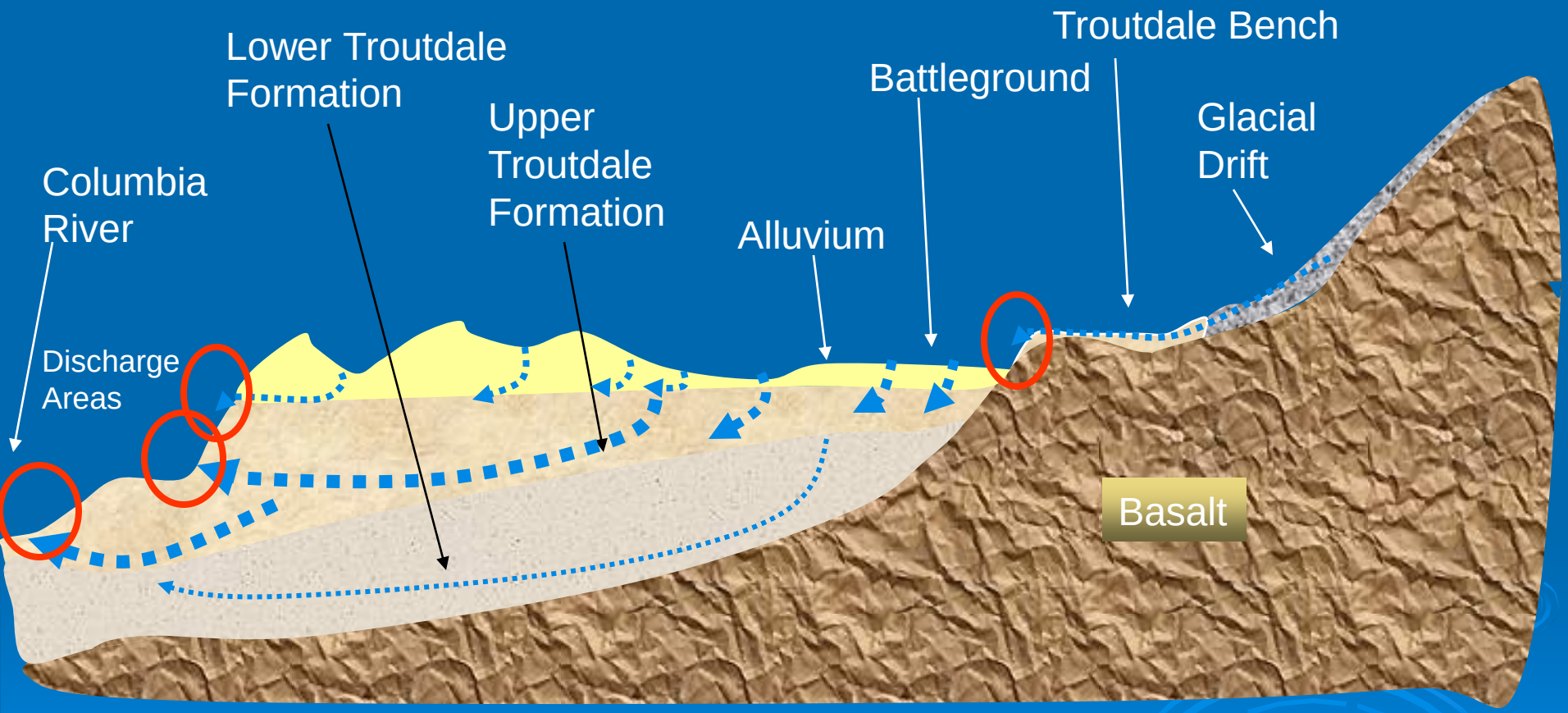
For deposits that were sorted by flowing water (fluvial):

- Coarser sediments are deposited closer to source of water (velocity higher)

- Finer sediment is further away from source where velocity and/or gradient is less

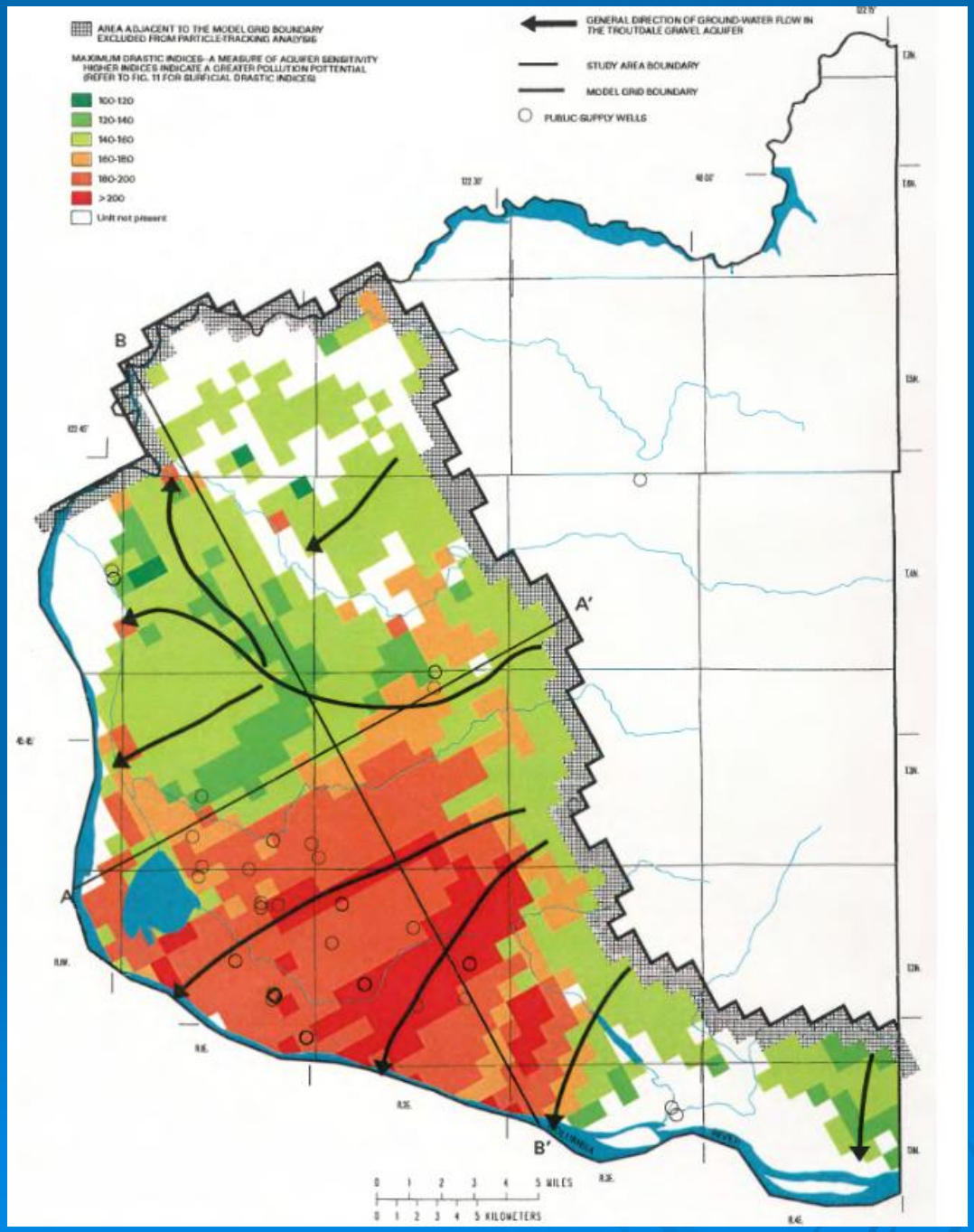


Geology & Regional Water Flow Patterns

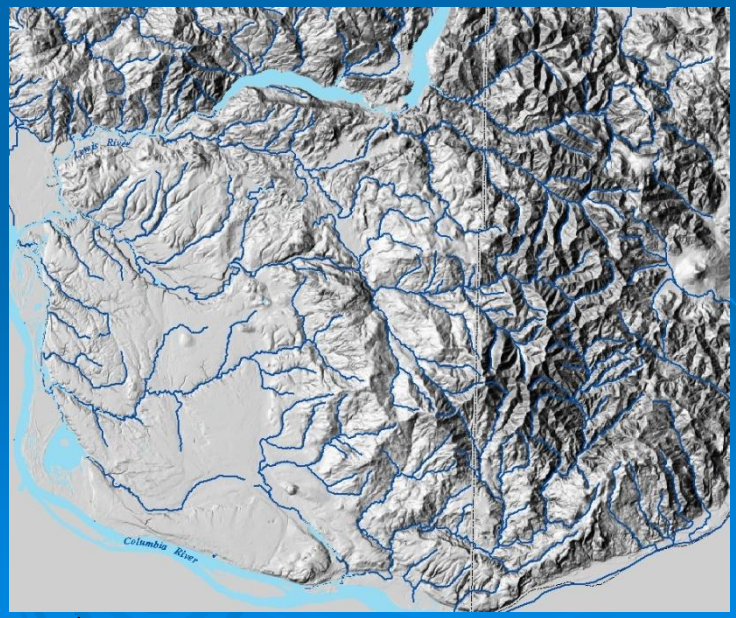


Upper Troutdale formation is the **saturated zone** and has the greatest quantity of groundwater. Majority of regional recharge appears to occur in the alluvial plain adjacent to the Battleground

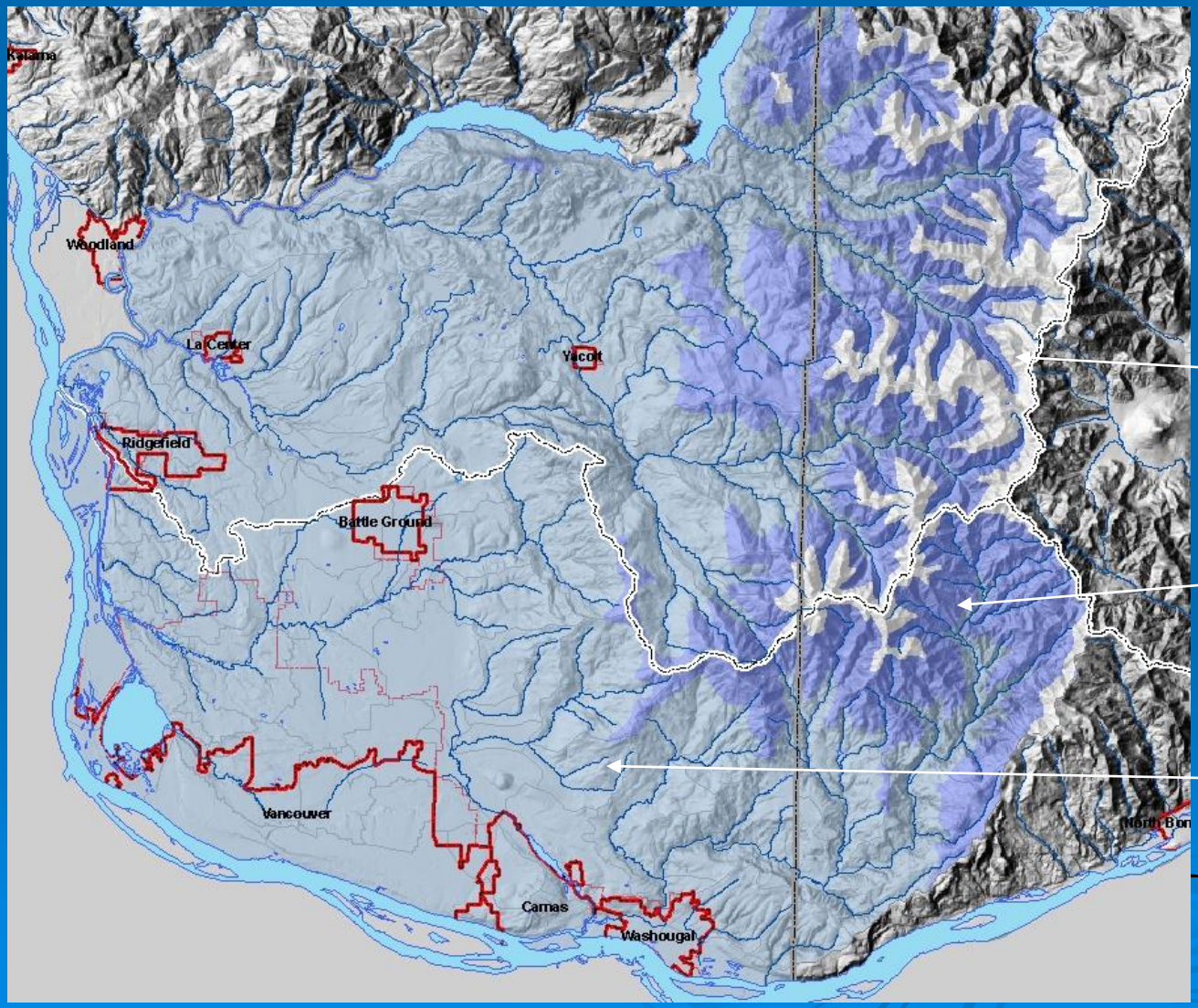
Subsurface flow moves through alluvium and laterally along boundary with Troutdale formation, **discharging in ravines and on slopes**.



Understand groundwater water flow patterns



Understand Precipitation Types



- Snow Dominated Zone
- Rain on Snow Zone
- Rain Zone

Delineate Hydrogeologic Units

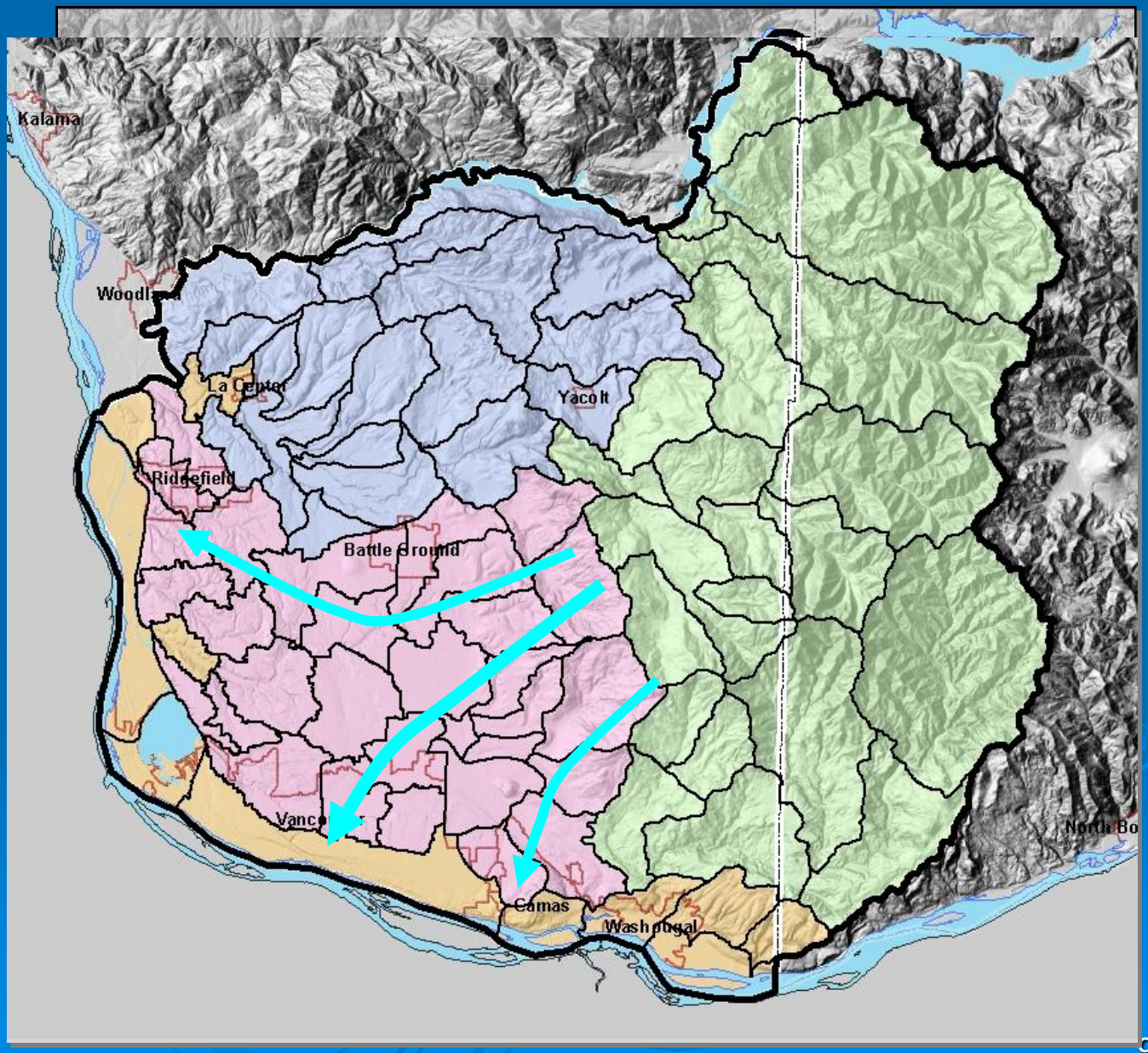
Based on Similar:

Precipitation Type

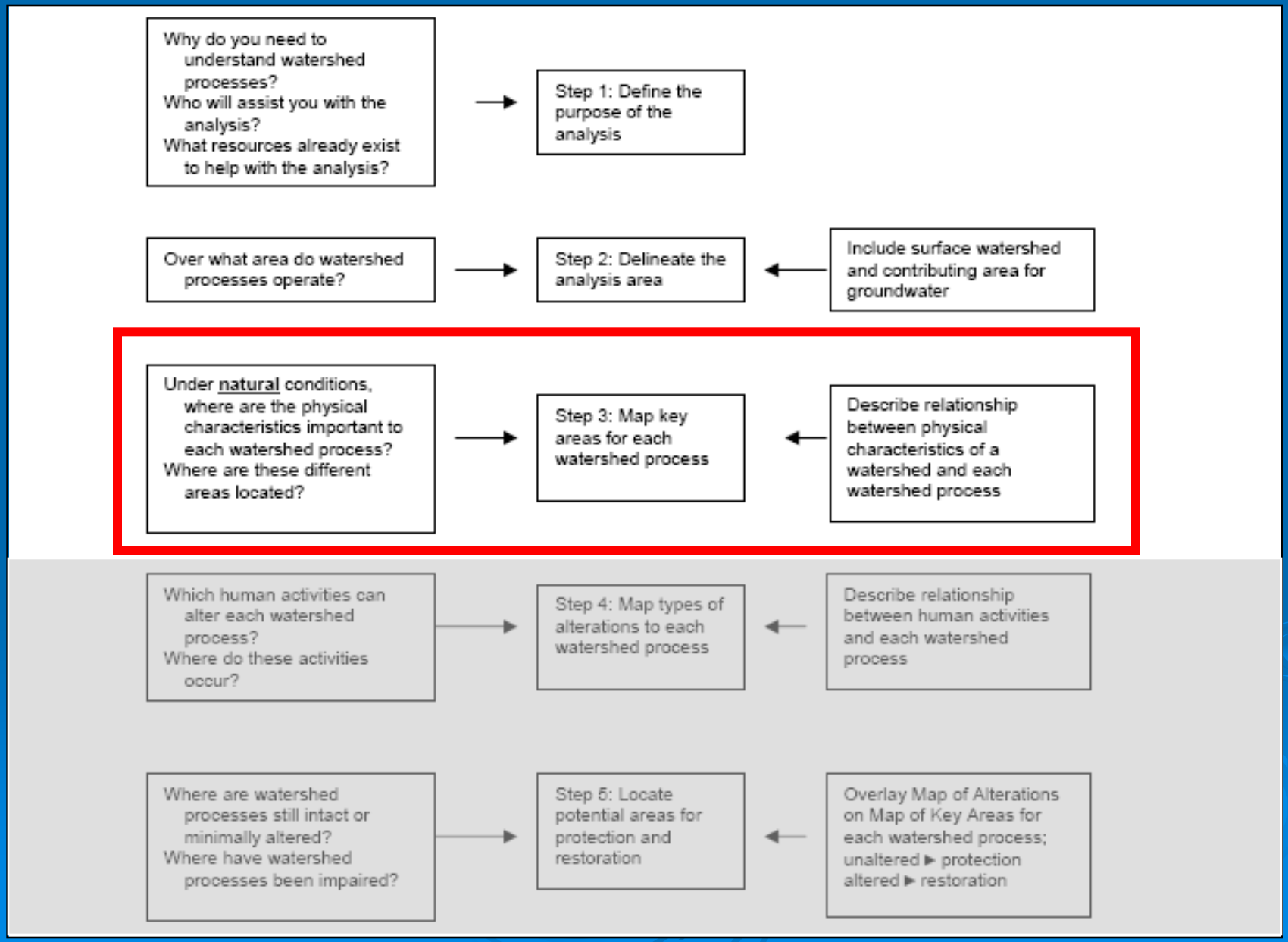
Geology

Landform

Groundwater Patterns



Step 3 – Characterize & Map Key Areas



Models for Scoring

Importance of a sub-basin in the hydrologic process =

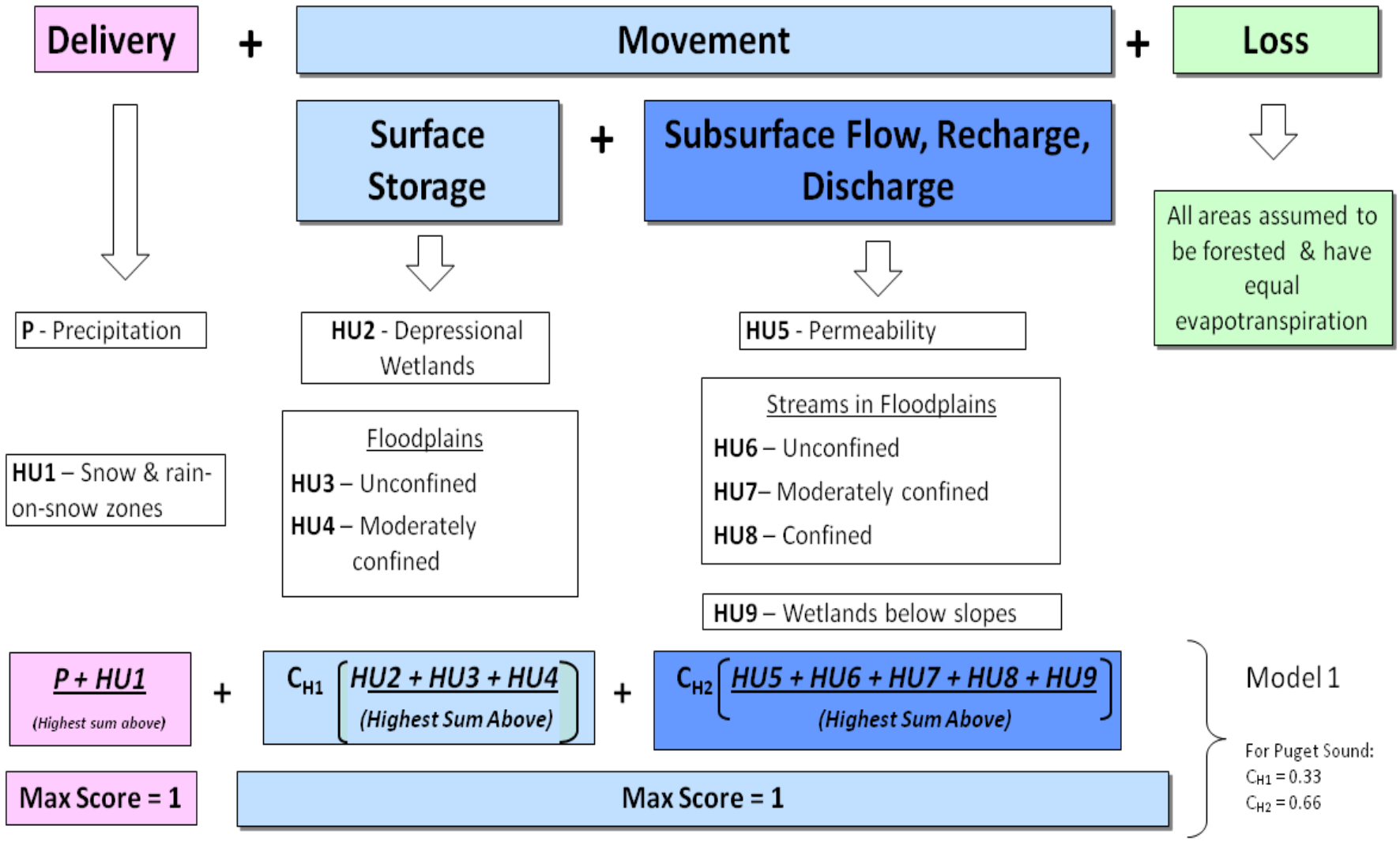
Important for delivery +

Importance for surface water +

Importance for groundwater +

Importance in evapotranspiration

Important Area for Water Process =



Example of Scoring for Importance Surface Water Variables

$$\frac{\text{Area of Wetlands}}{\text{Area of Sub-basin}} = \text{\% of wetlands in sub-basin}$$

Scoring Based on Total Range of Wetlands in Analysis Area:

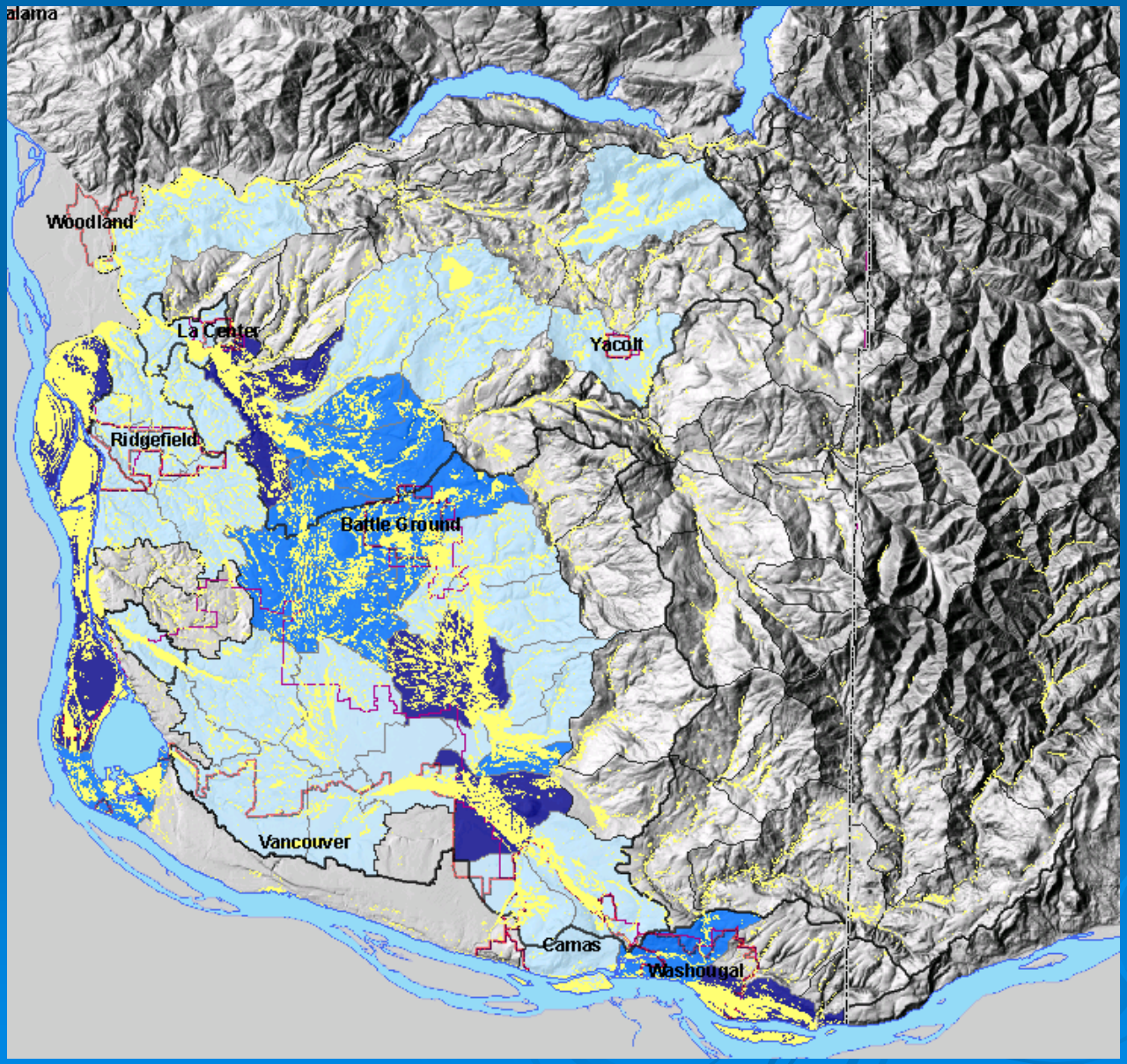
0 to 5% = 0

5 to 10% = 1

10 to 20% = 2

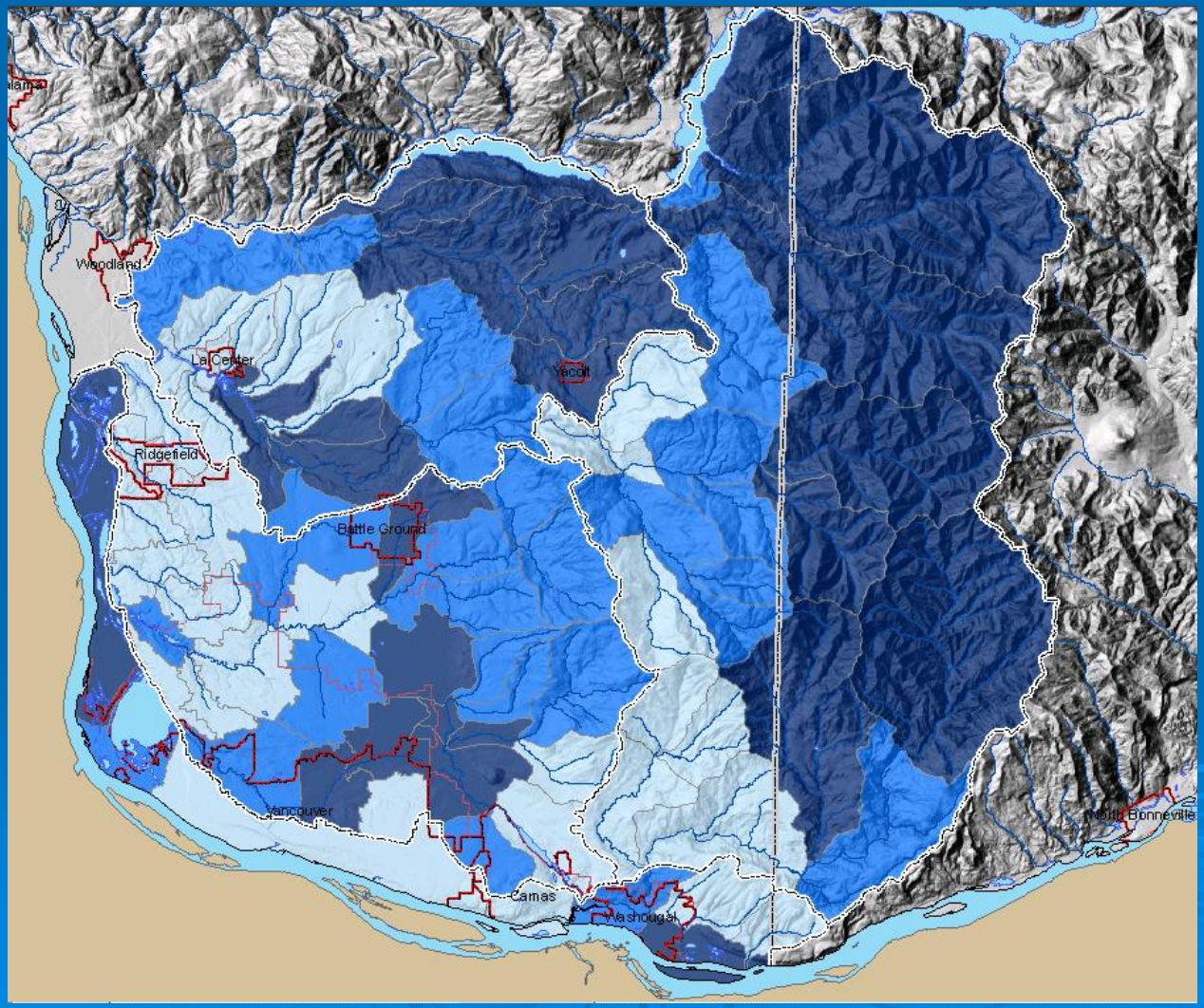
>20% = 3

Results of Importance of Wetlands

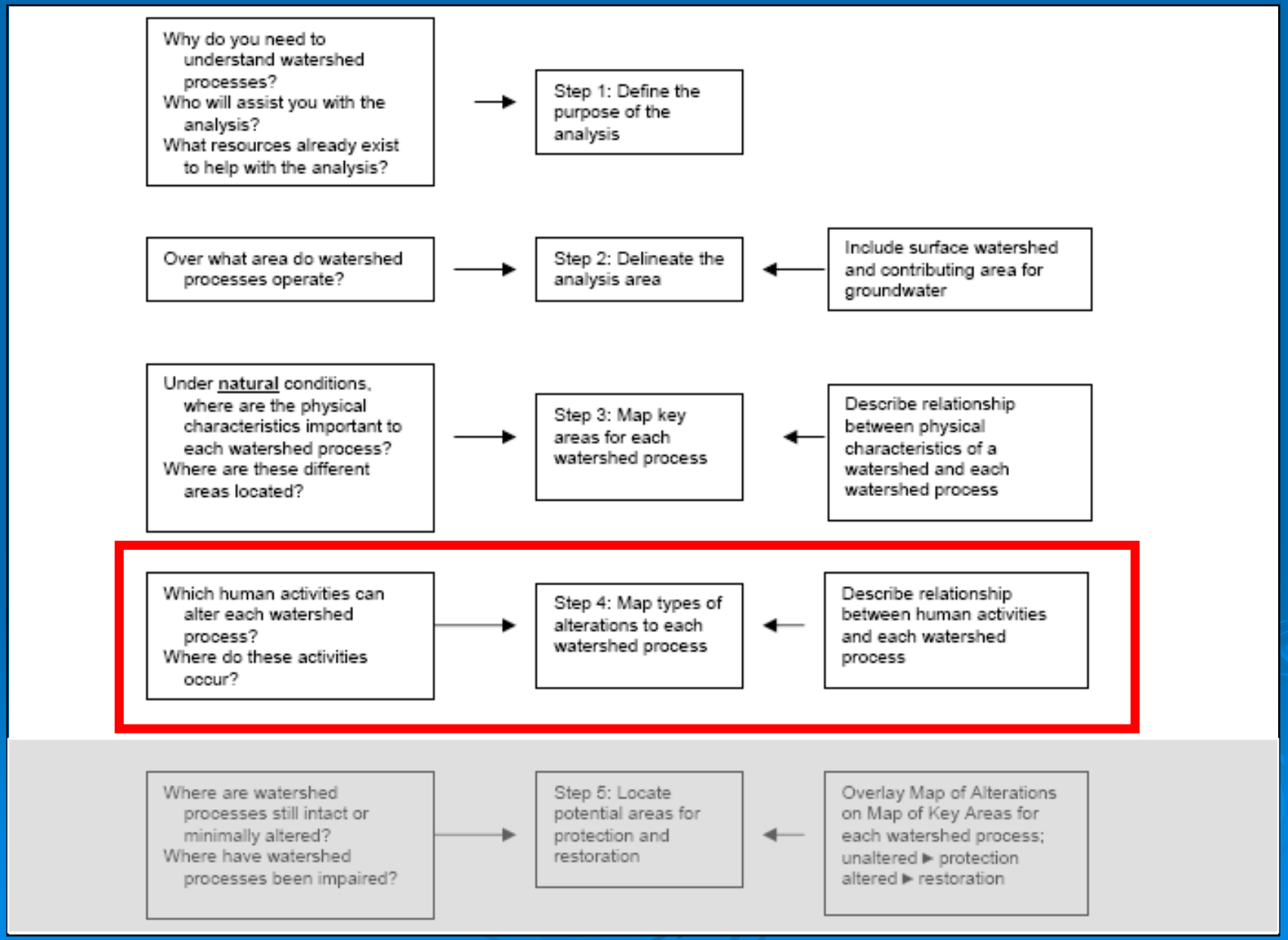


- High
- Moderate
- Low
- Wetlands Layer

Characterize and Map Important Areas for Hydro Process

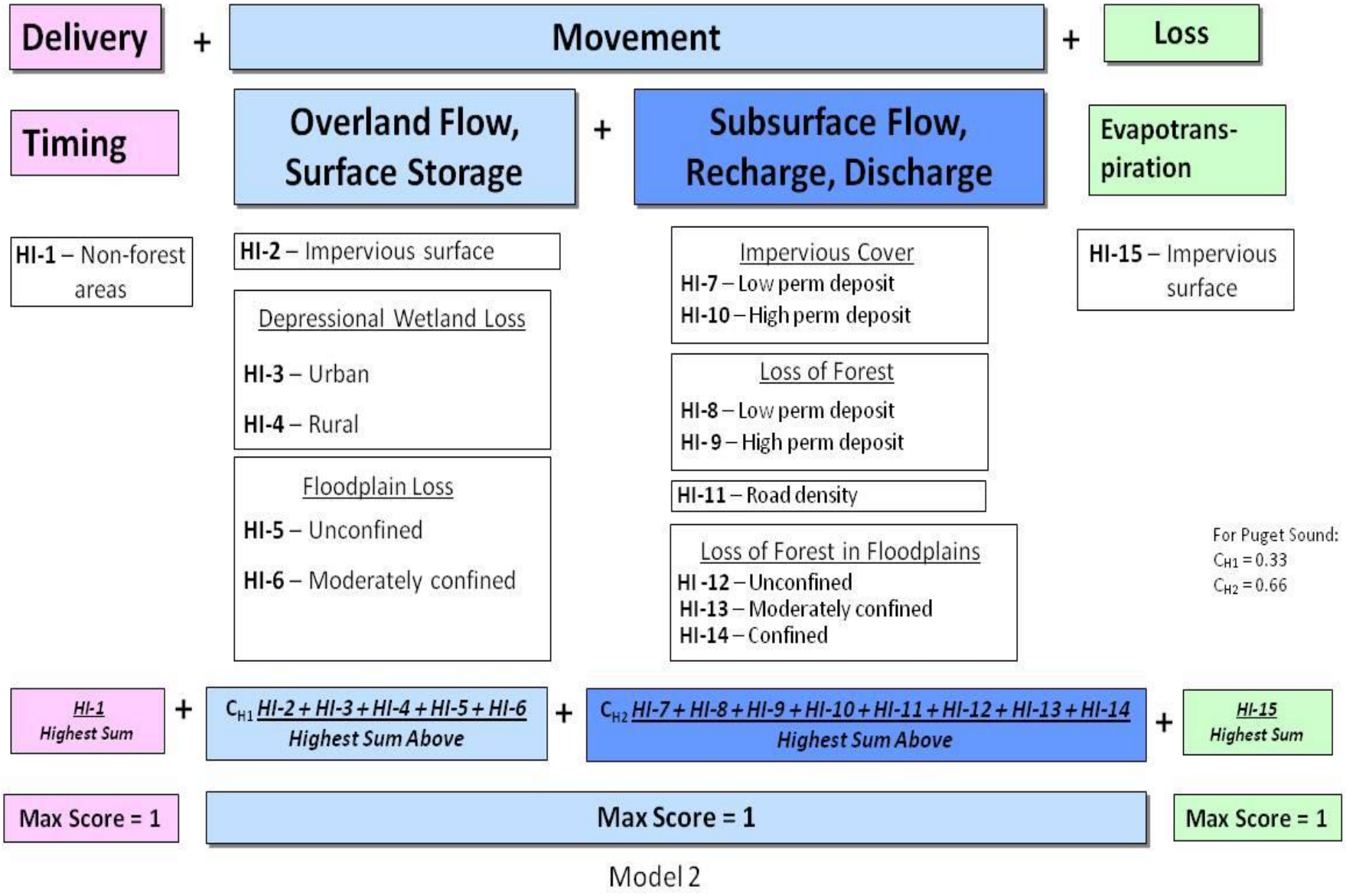


Step 4 – Identify and Map Impairments



Pg. B-47

Impairments to Water Process =



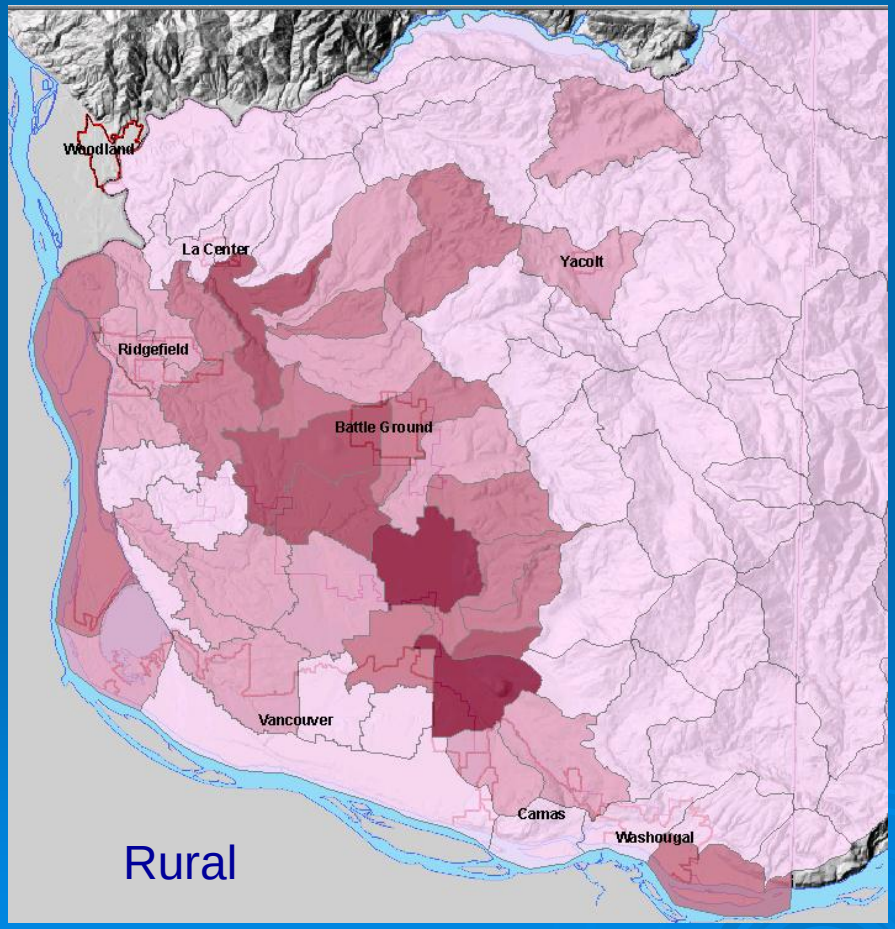
Model 2

Example of Scoring for Impairment Surface Water Variables

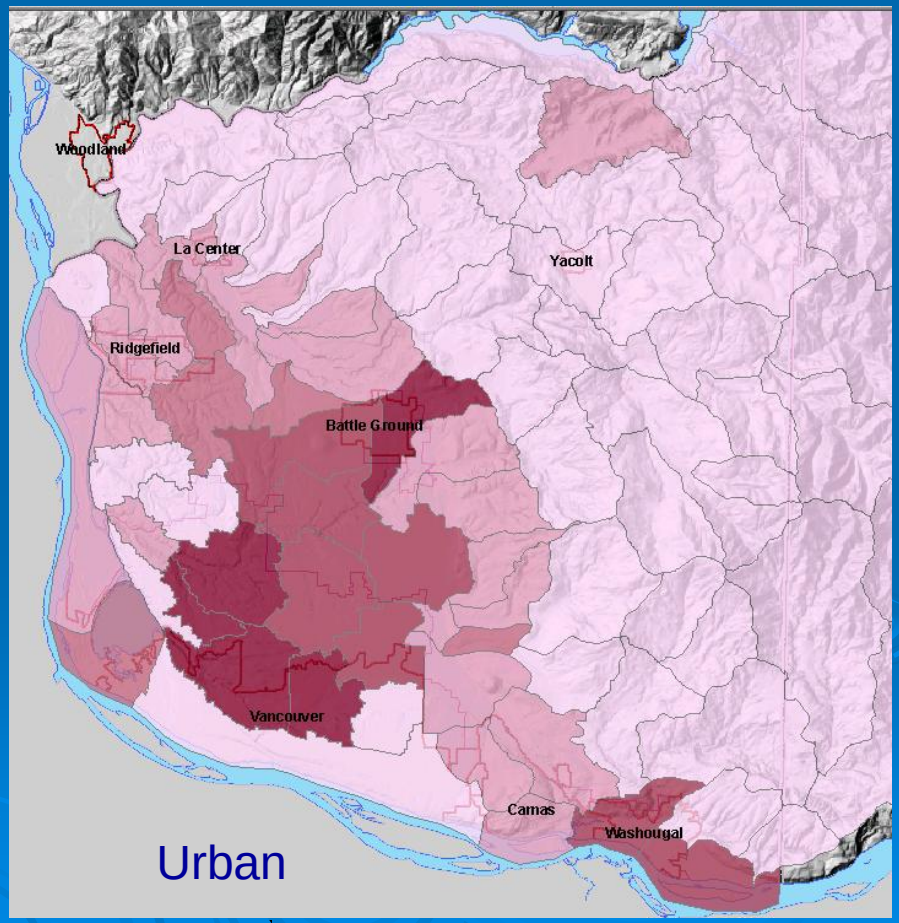
$$\frac{\text{Area of Rural Wetlands}}{\text{Area of Sub-basin}} \times 2 = \text{Score}$$

$$\frac{\text{Area of Urban Wetlands}}{\text{Area of Sub-basin}} \times 3 = \text{Score}$$

Results of Impairments to Wetlands

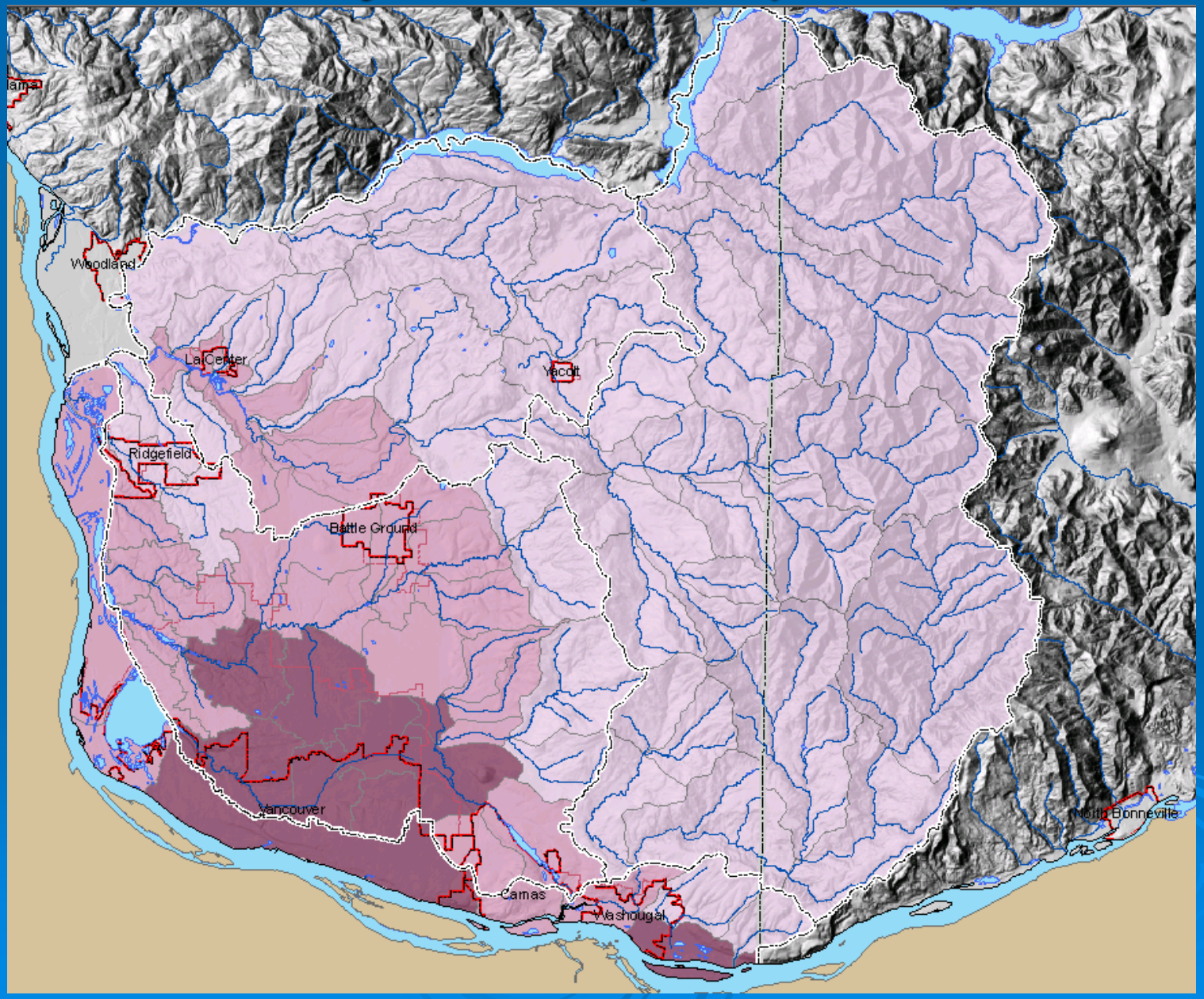


Rural



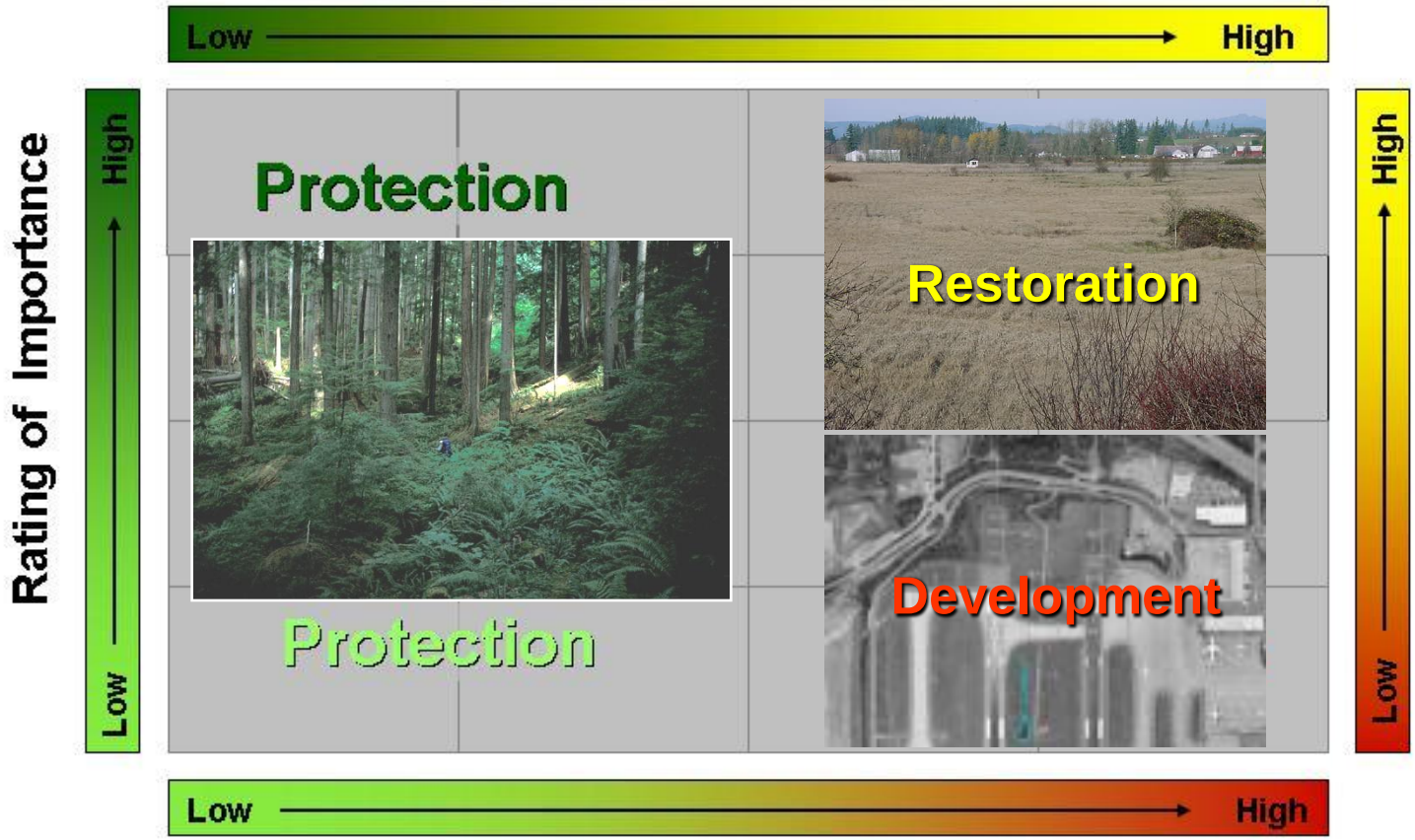
Urban

Identify and Map Impairments

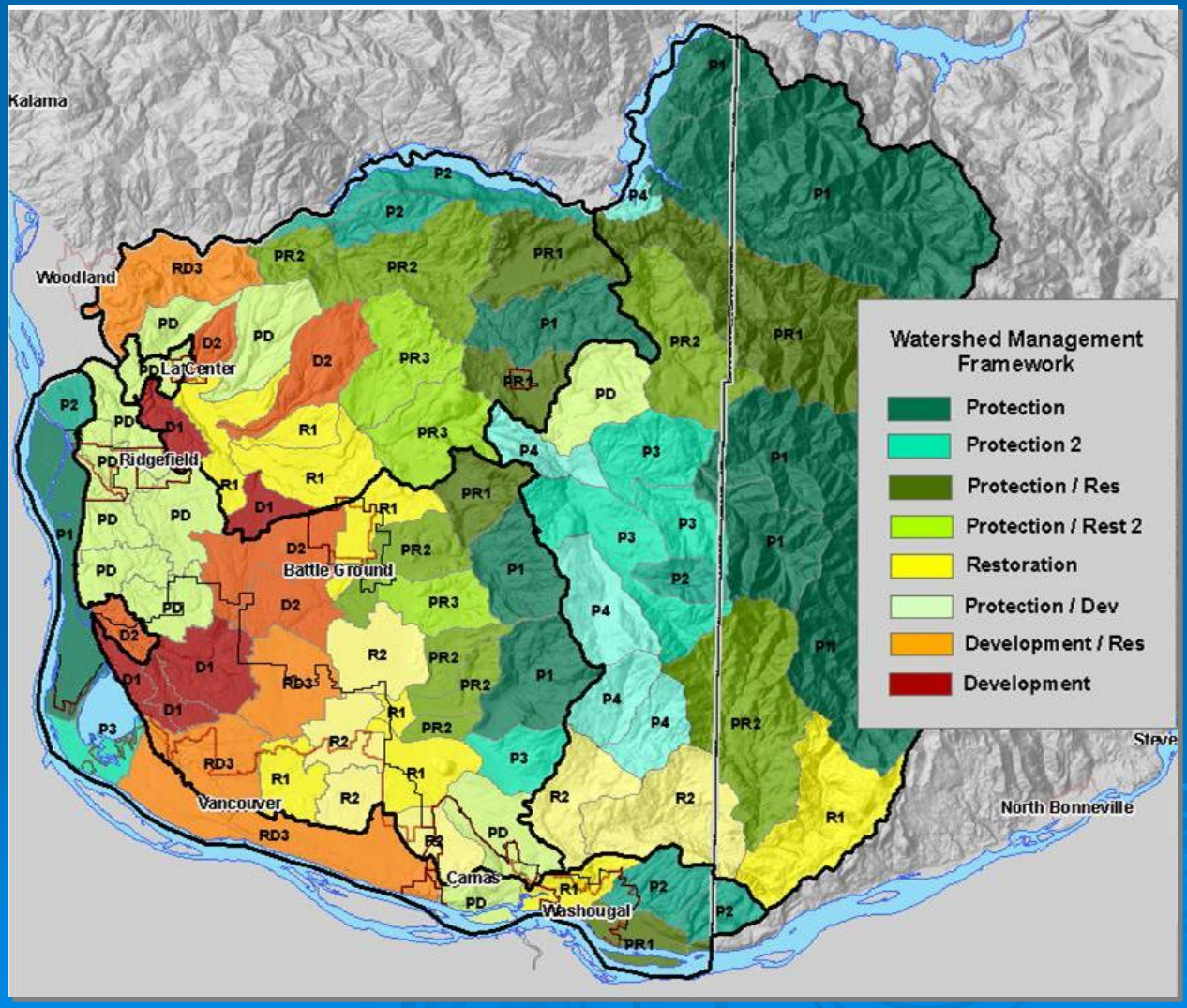


Step 5 – Locate Areas for Protection and Restoration

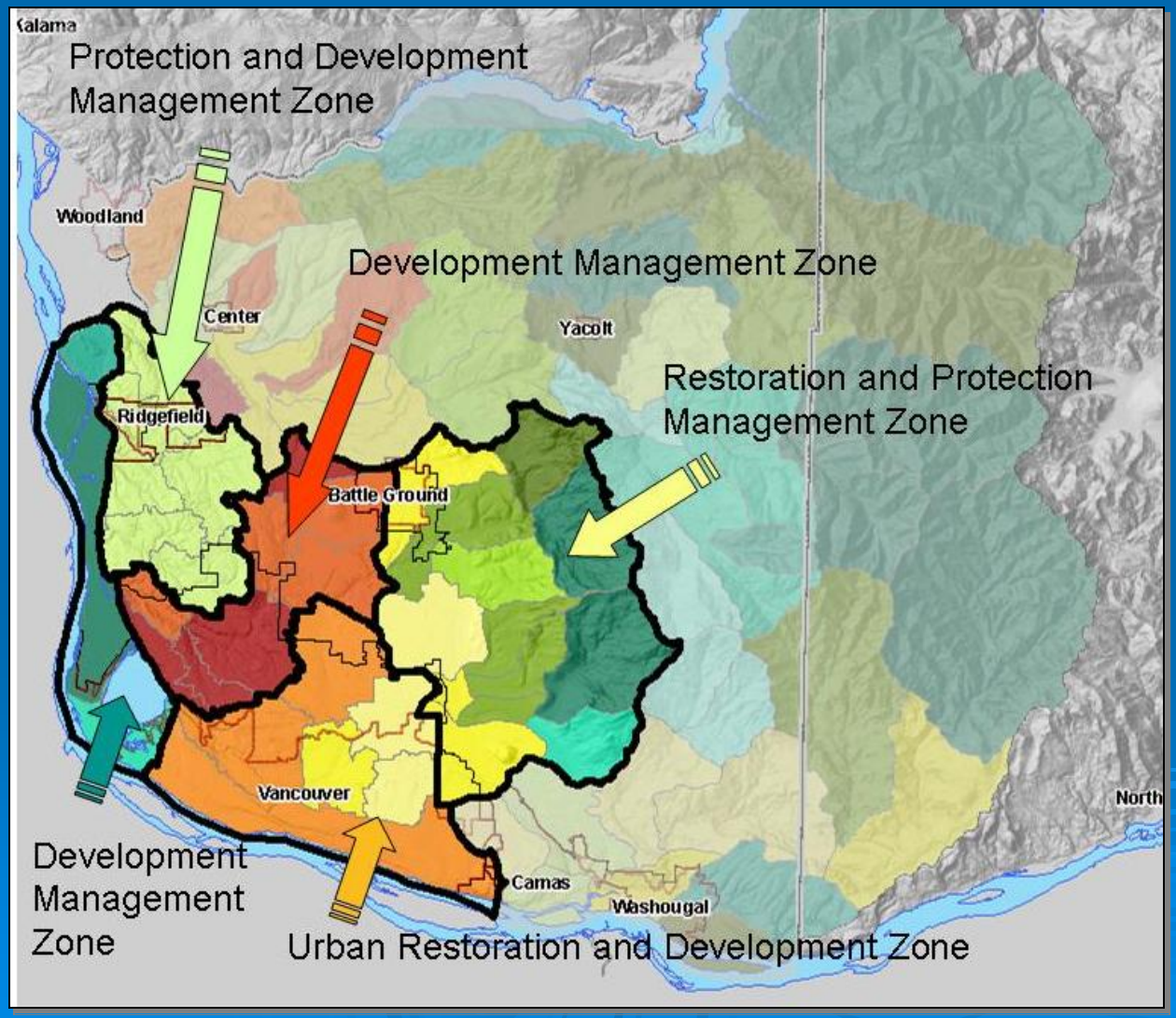
Watershed Management Matrix



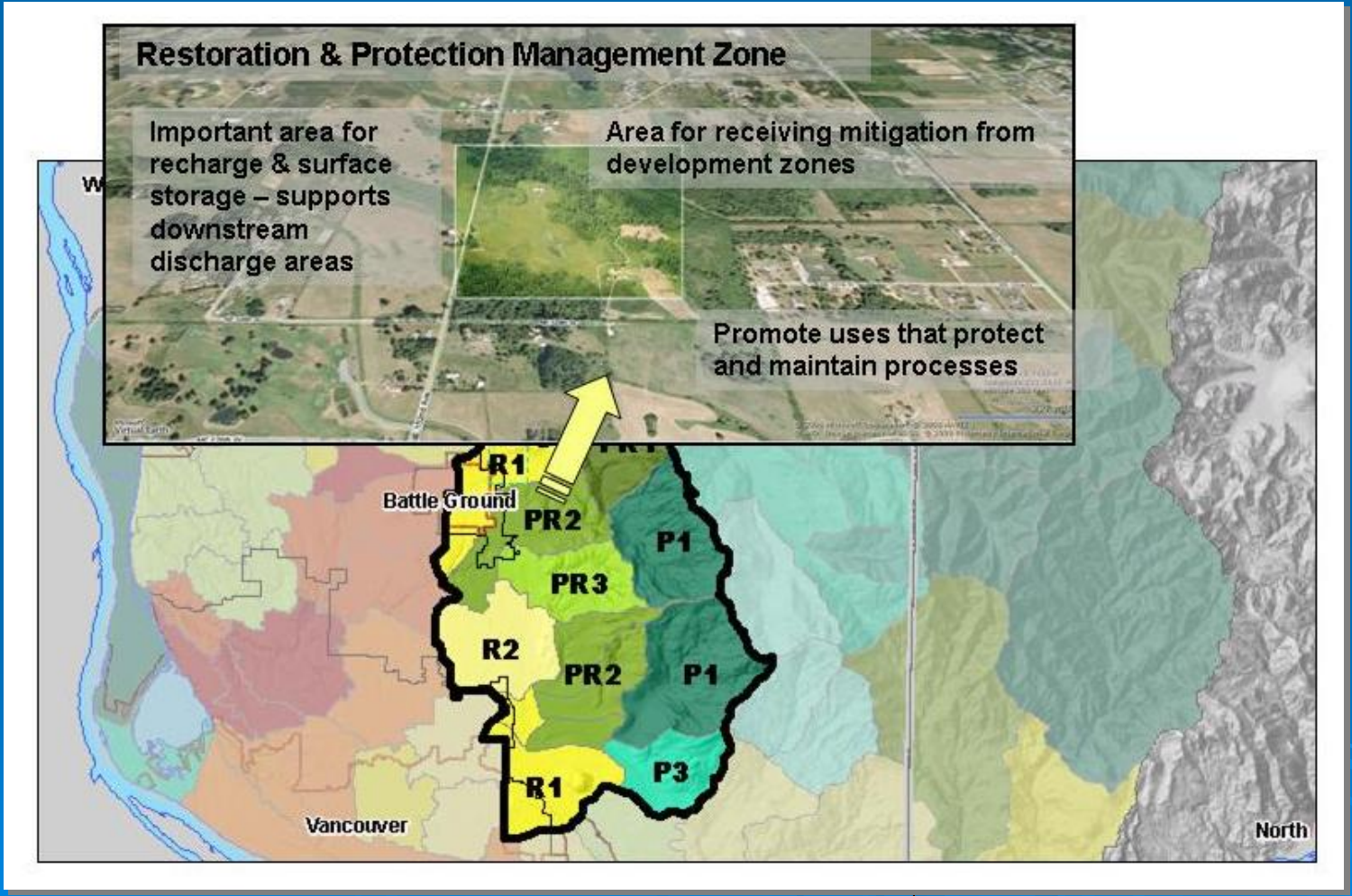
Areas for Protection and Restoration



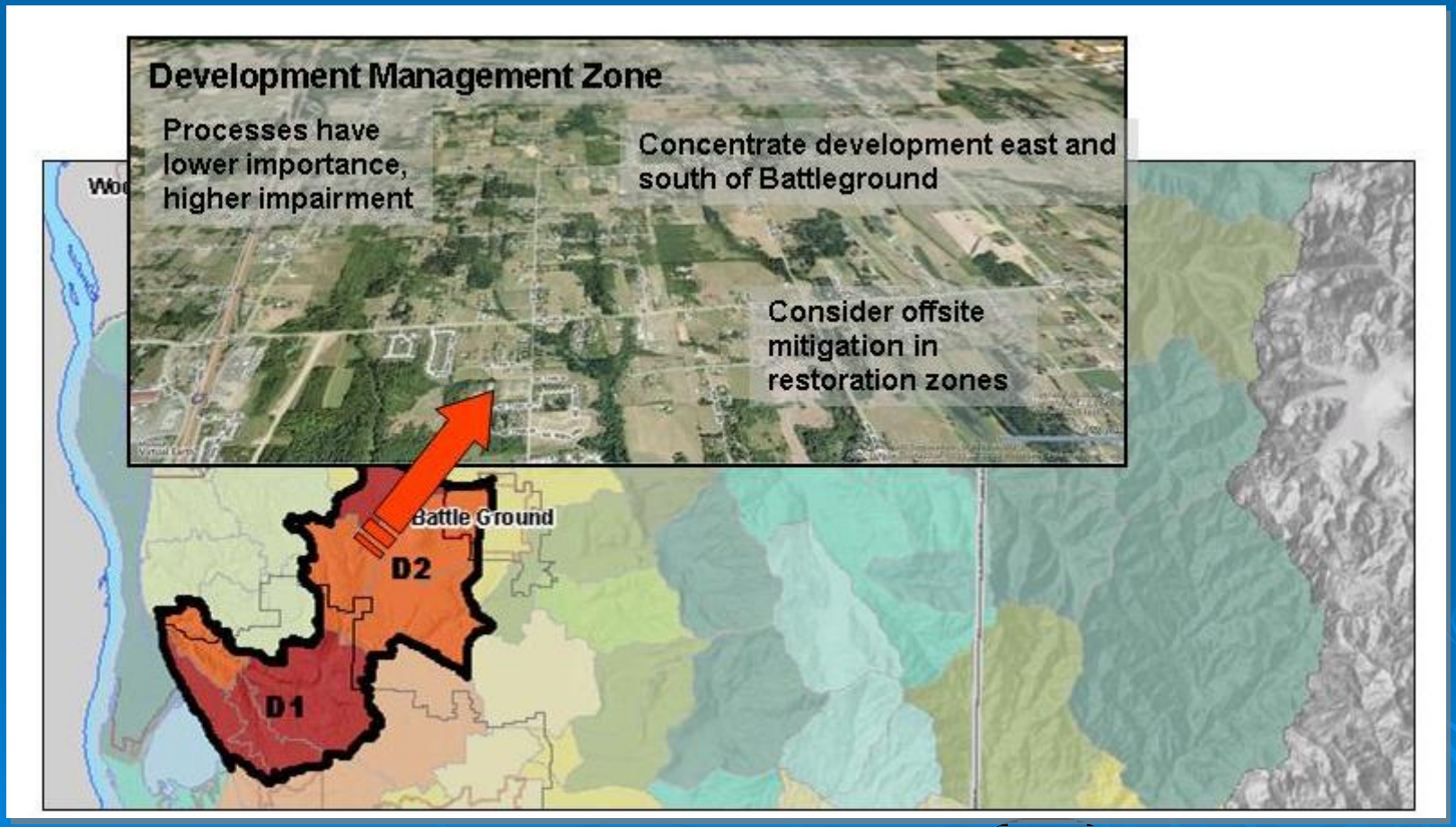
Locate Areas for Protection and Restoration



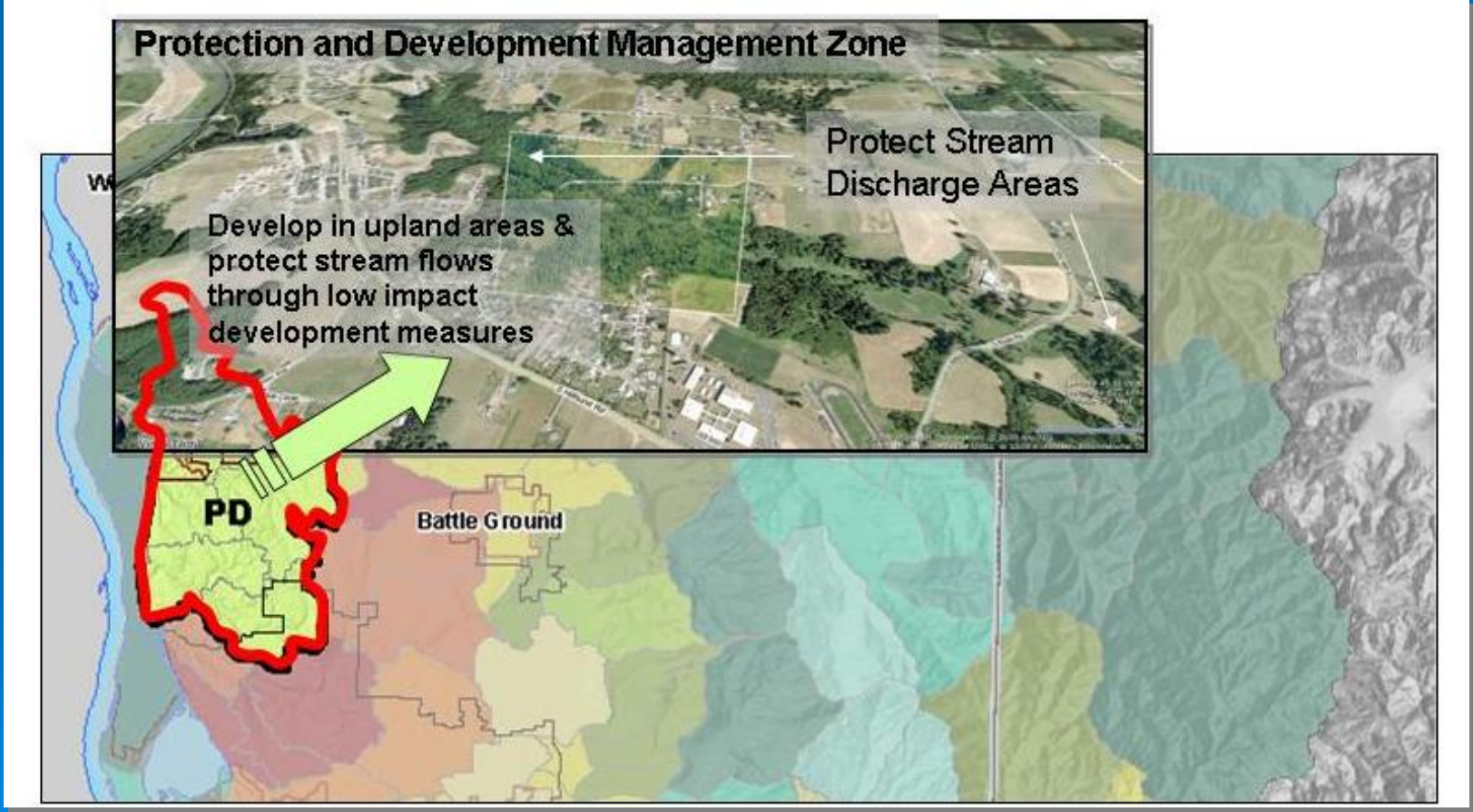
Locate Areas for Protection and Restoration



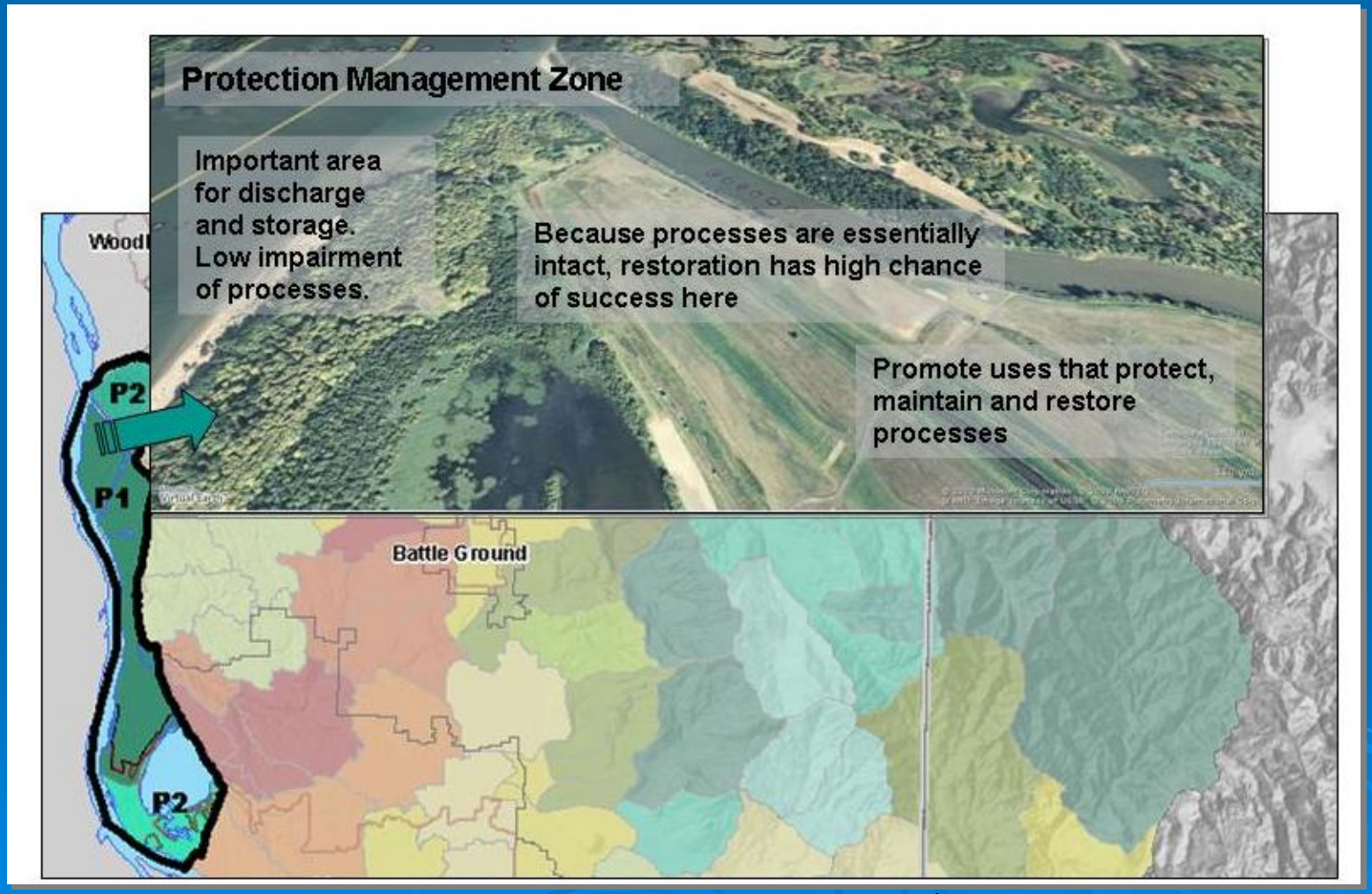
Locate Areas for Protection and Restoration



Locate Areas for Protection and Restoration



Locate Areas for Protection and Restoration



Introduction to Models

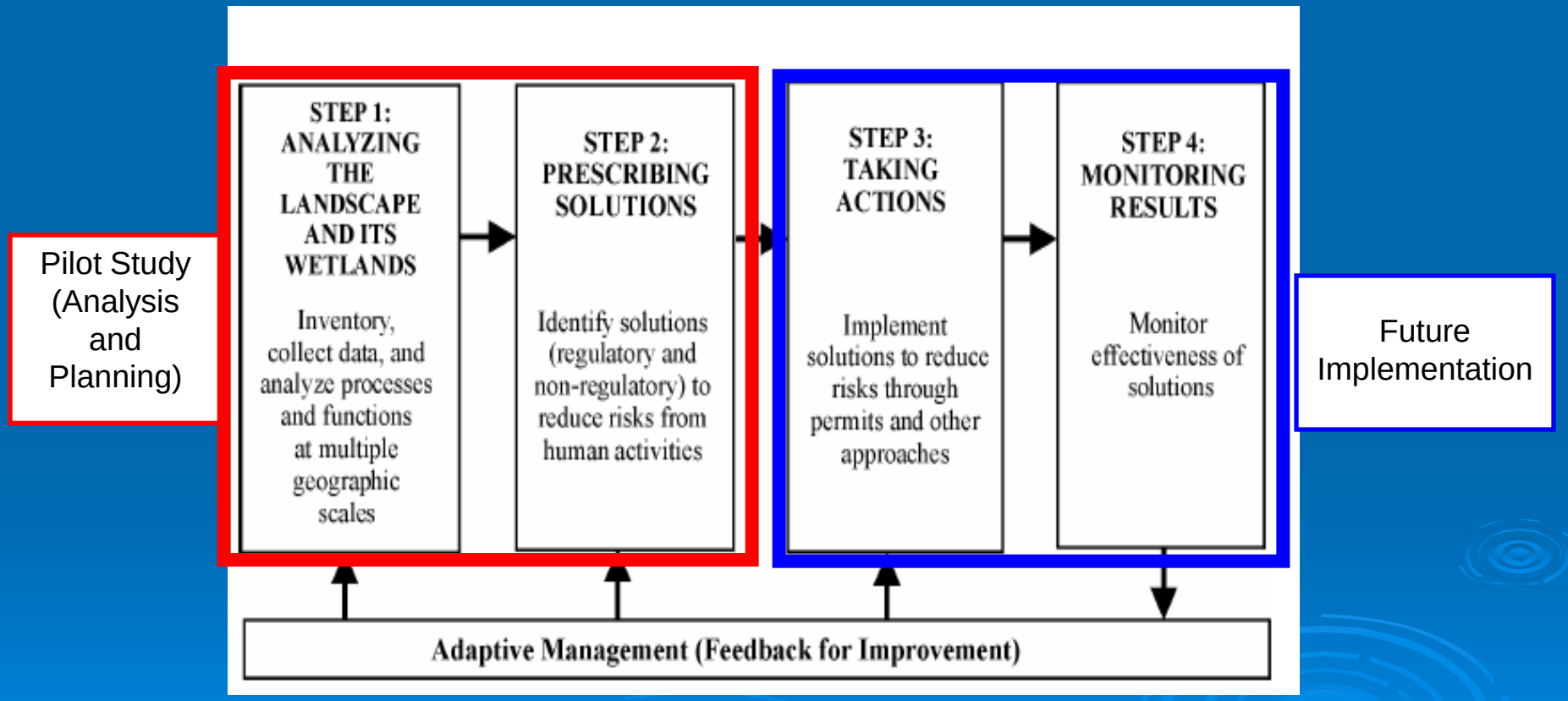
Applying the Characterization to Planning & Permitting in Birch Bay

A Watershed Based Management Plan for Birch Bay

A Coordinated Approach

- Whatcom County
- Local Citizen Groups
- WA Dept of Fish & Wildlife
- WA Dept of Ecology
- WA Dept of Transportation
- WA Dept of Community Trade & Economic Development
- Puget Sound Partnership
- Environmental Protection Agency

Watershed Planning Process



Objectives of Watershed Plan

- Identify important ecosystem relationships within the Birch Bay watershed
  - Areas sensitive to changes from land use
  - Areas where protection and restoration can address current problems (reduce risk)

- Provides a framework for coordination of planning activities
  - Comprehensive Plan, Shoreline Management Plan and Critical Areas Ordinance update

Components of the Plan

Inventory of (Step 1)

- Environmental Problems (Risks)
- Wetlands
- Streams and Riparian areas

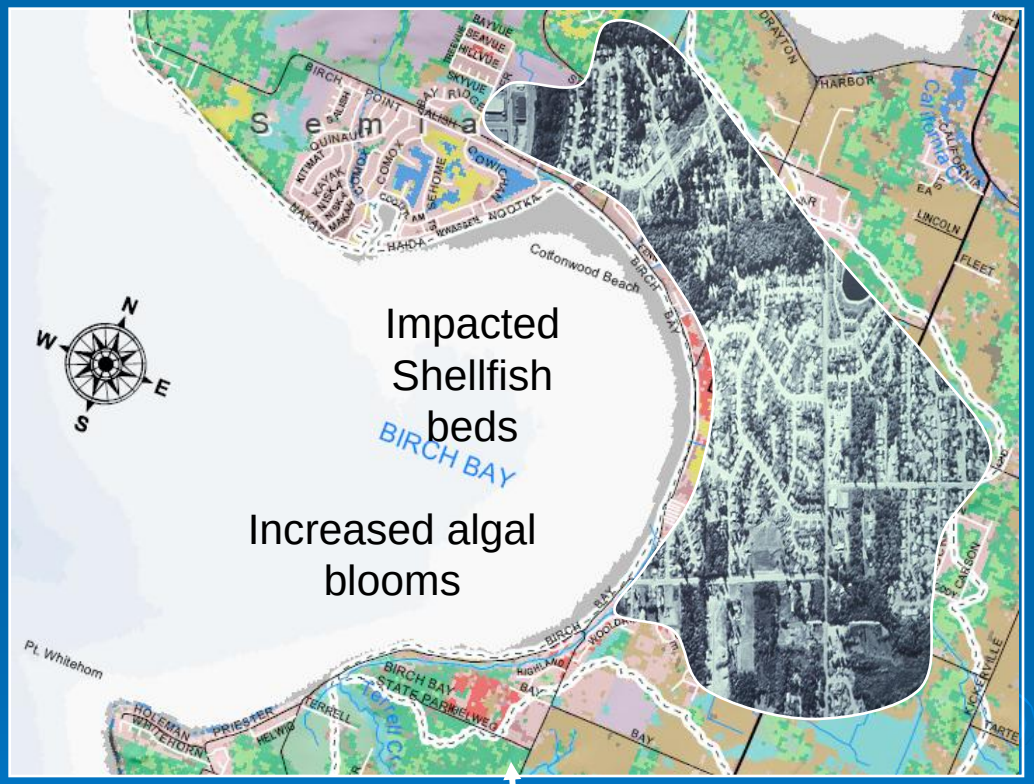
Analysis of (Step 1)

- Water quality and water flow processes
- Wildlife and habitat conditions
- Future development patterns

Synthesis to develop watershed solutions (Step 2)

Step 1 - Inventory of Environmental Problems or “Risks”

- Water quality in Birch Bay
  - Pathogens
  - Nutrients
- Large population increase
- Loss of habitat and wildlife
- Decreased “quality of life” for residents



Potential loss of heron rookery

Step 1 – Analysis

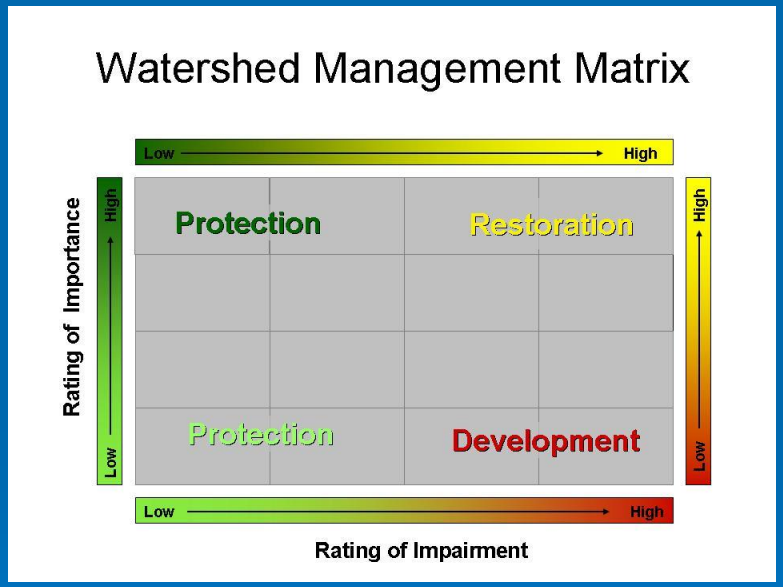
Identify at three scales (broad, mid, fine) in watershed:

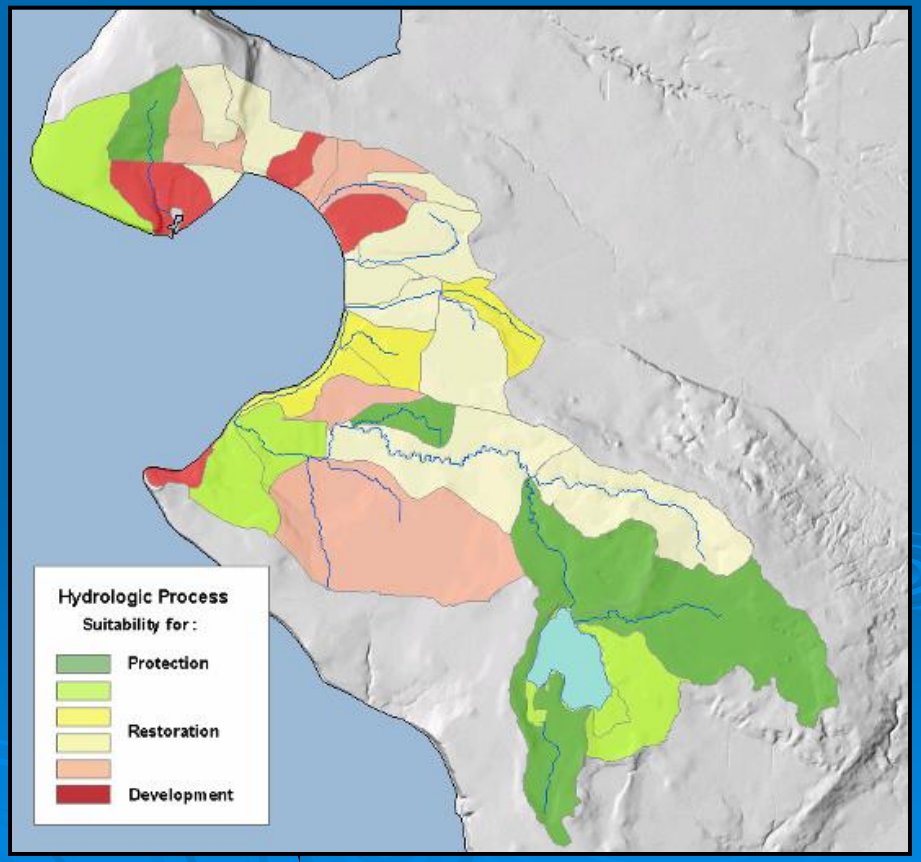
- Areas important for maintaining watershed processes and wildlife
- How these important areas have been altered
- Areas for protection and restoration

Characterization of Watershed Processes:

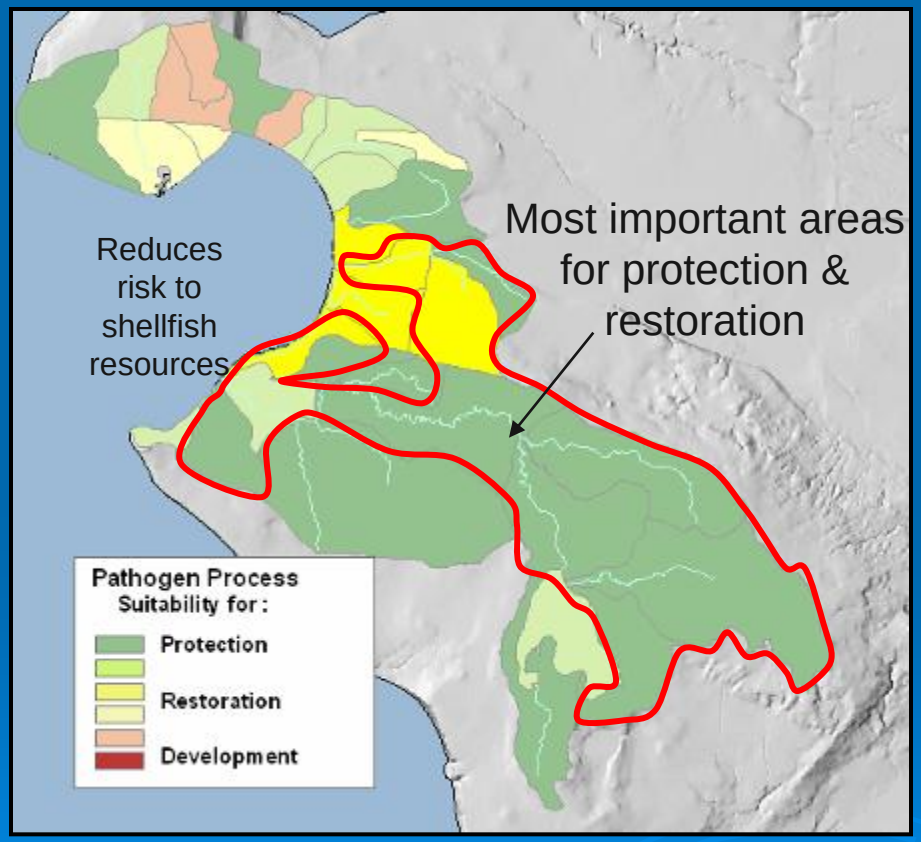
Water Flow
Nutrients
Pathogens

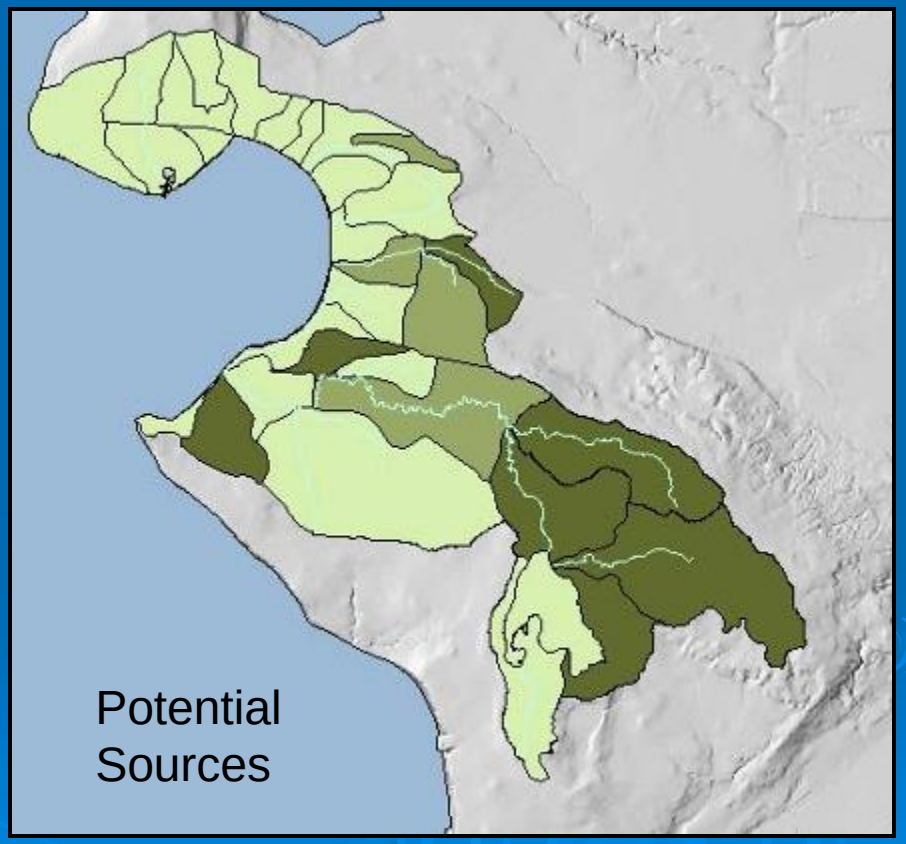
Important Areas for Restoring & Protecting Hydrologic Processes





Important Areas for Pathogen Process Relative to Potential Sources





Fish & Wildlife Watershed Analysis

Broad and Mid Scale

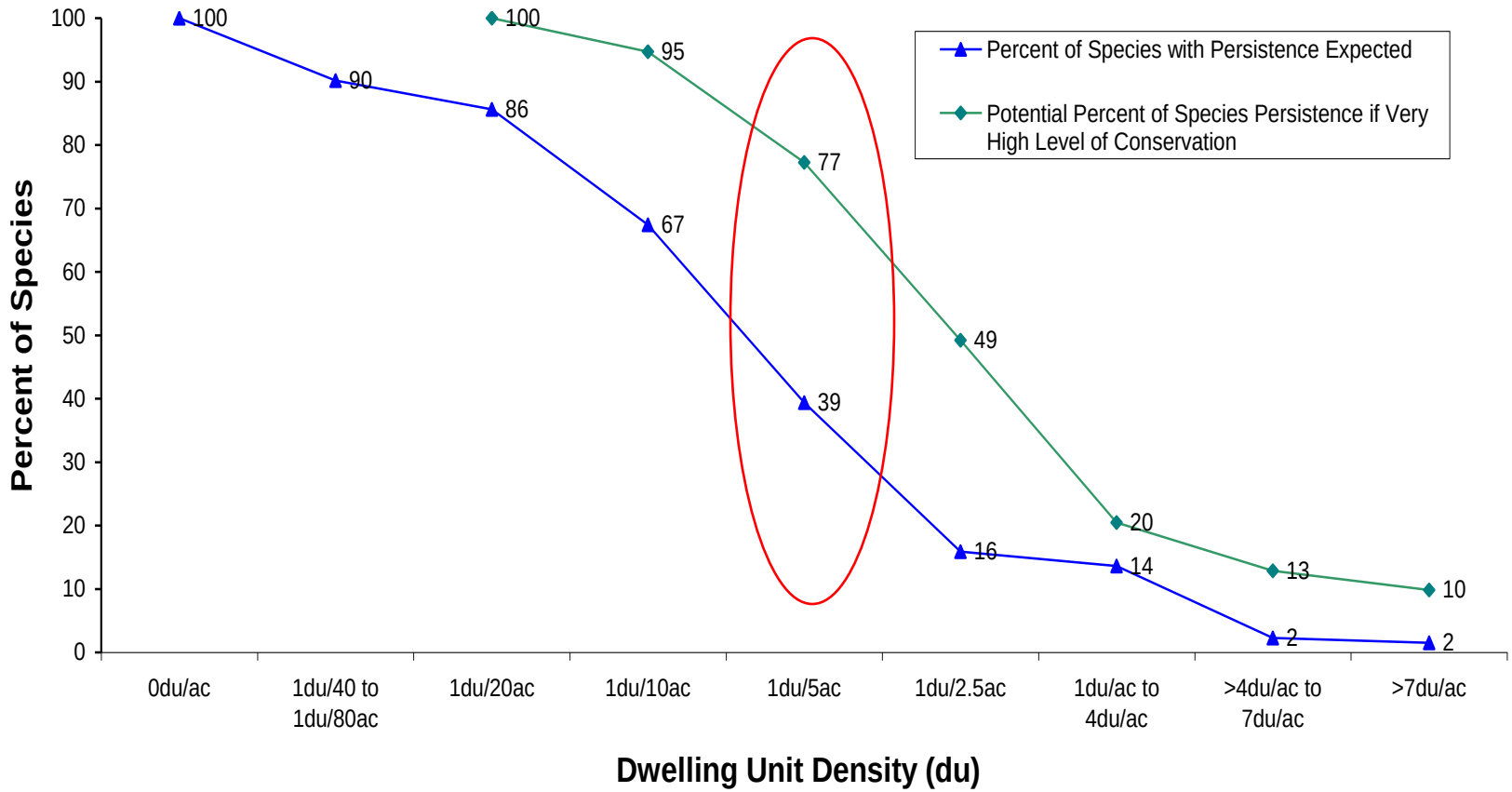
Current Conditions

Why Plan for Wildlife?

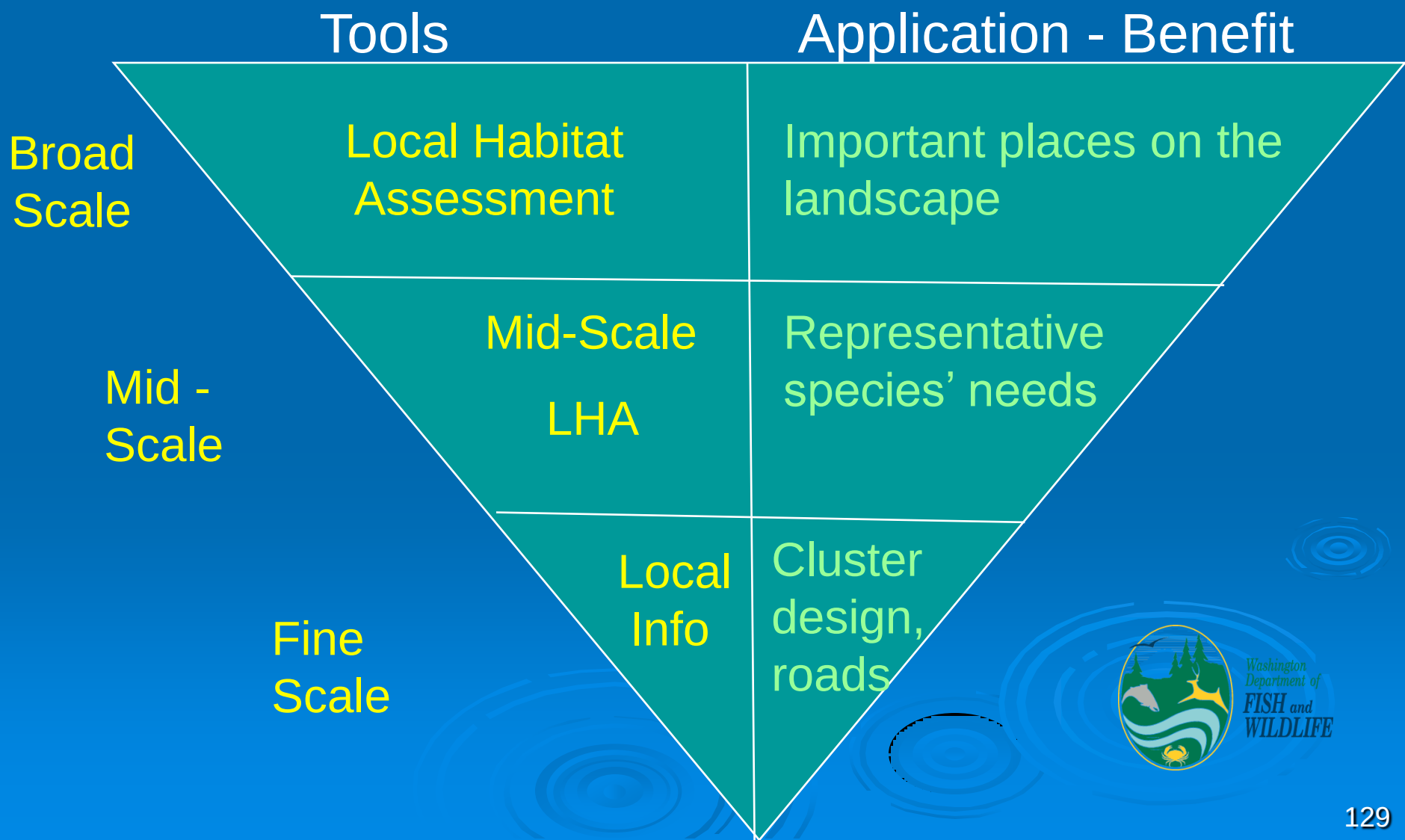
Birch Bay Watershed – Rich and Diverse Fauna

- 230 Terrestrial and Avian Species
- 80 WDFW Priority Species
- 21 Classified as Species of Greatest Conservation Need
- 24 Species with State Listing Status
- 3 Salmonid Species
- Very Productive Marine Habitats

Why Plan for Wildlife?

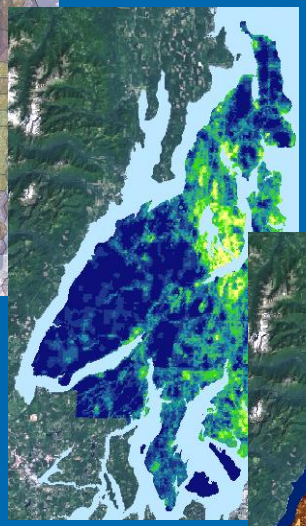


Landscape Planning for Washington's Fish and Wildlife

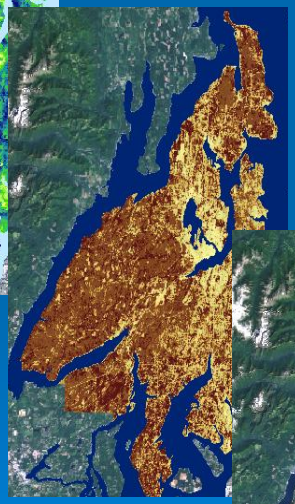


Local Habitat Assessment

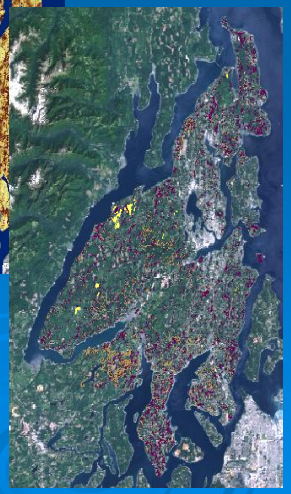
Ecoregional Assessments



Land Conversion



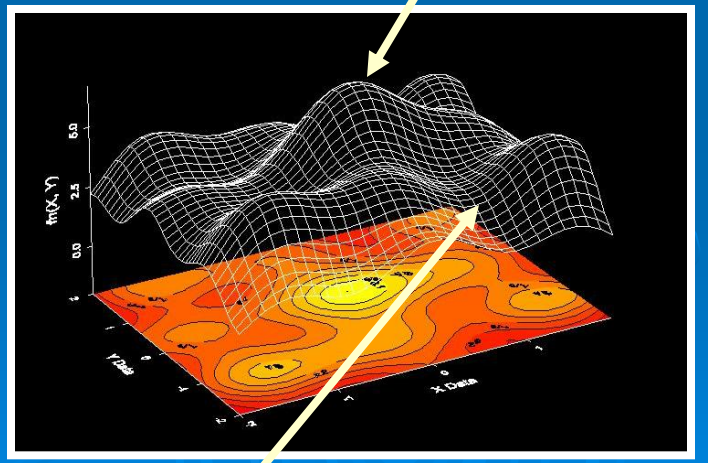
Road Density



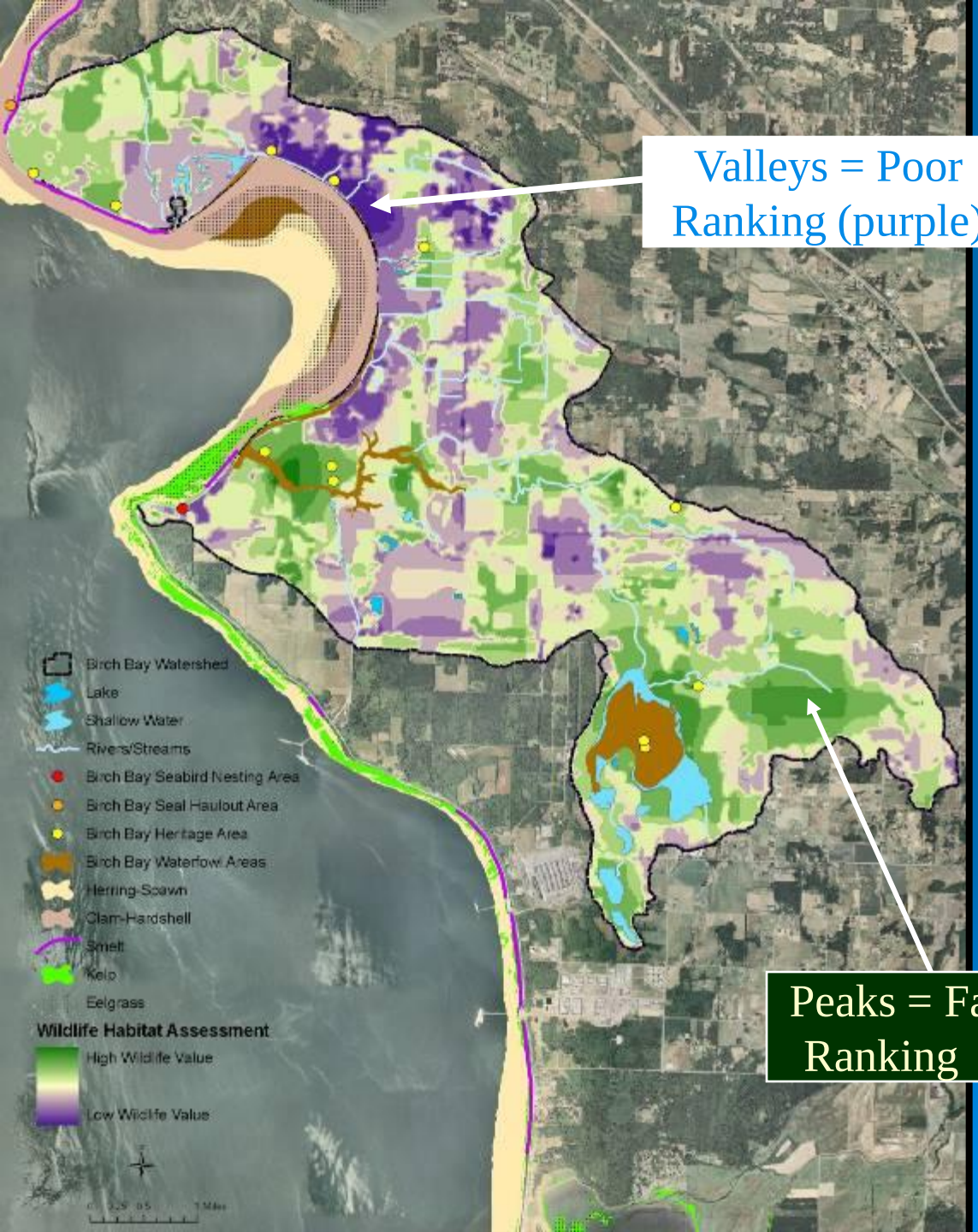
PHS/Heritage data (local empirical data)

=

Peaks = Favorable Ranking



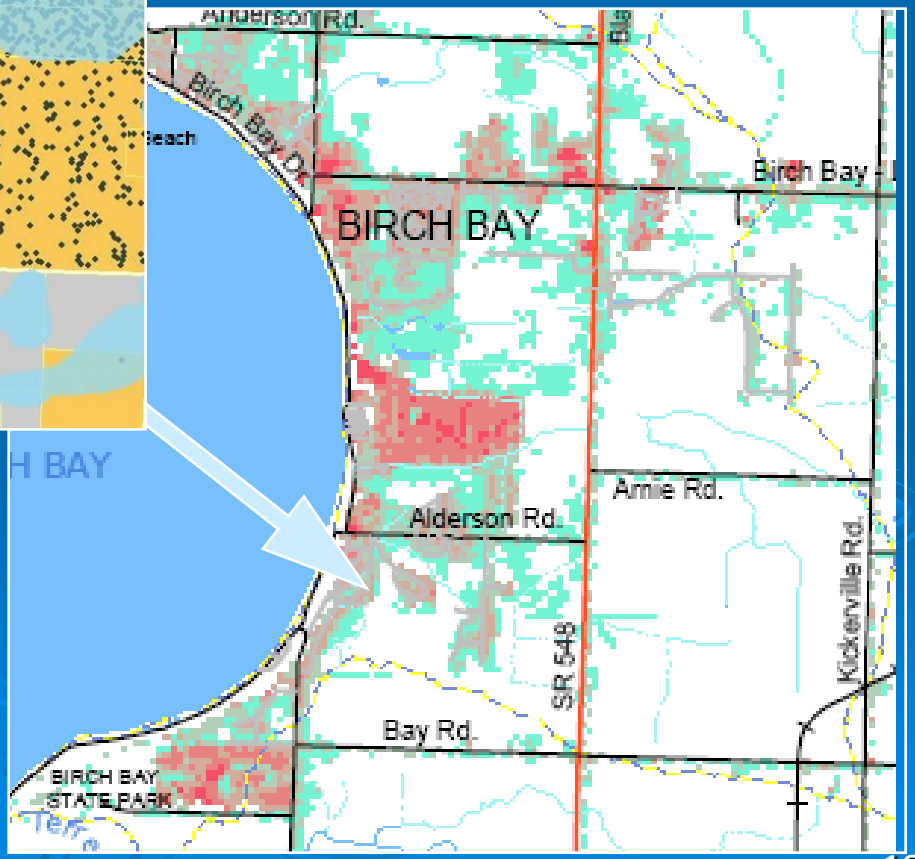
Valleys = Poor Ranking



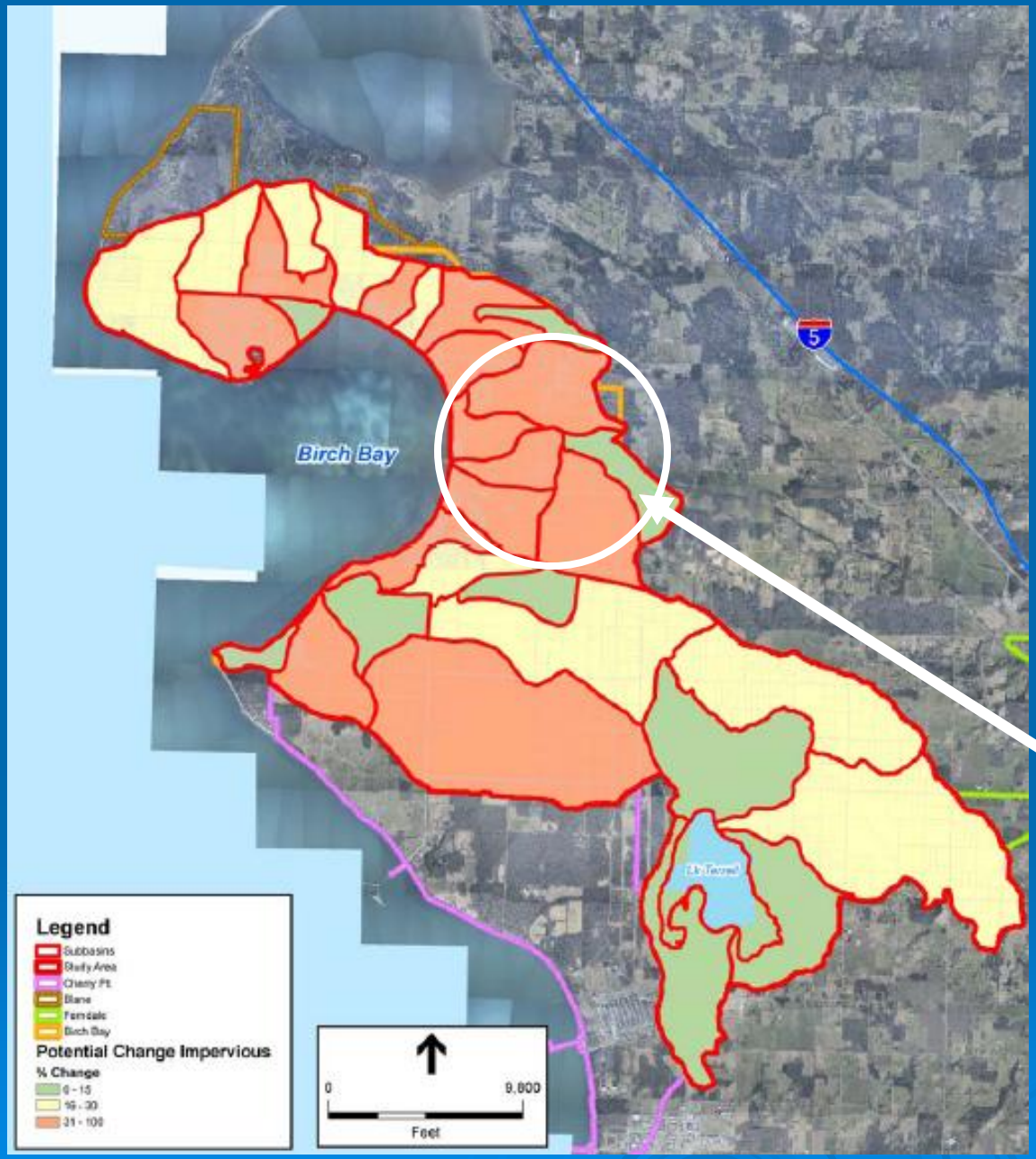
Results of Fish & Wildlife Analysis

Local Habitat Assessment – Broad Scale

Effects of Growth on the System



- Impervious Surface Analysis

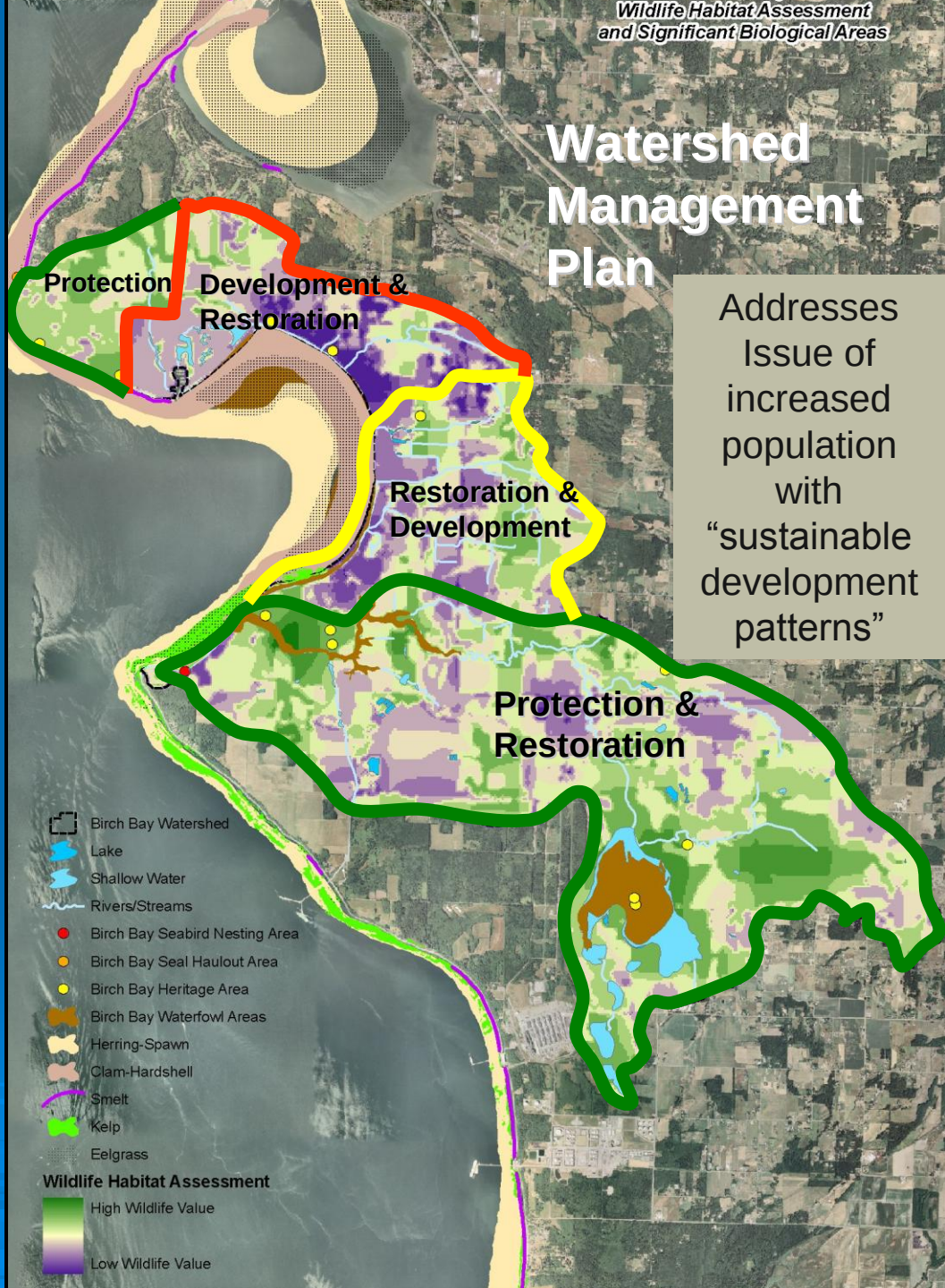


Potential Change in Impervious Cover

Conflicts in Central Sub-basins With Characterization Results

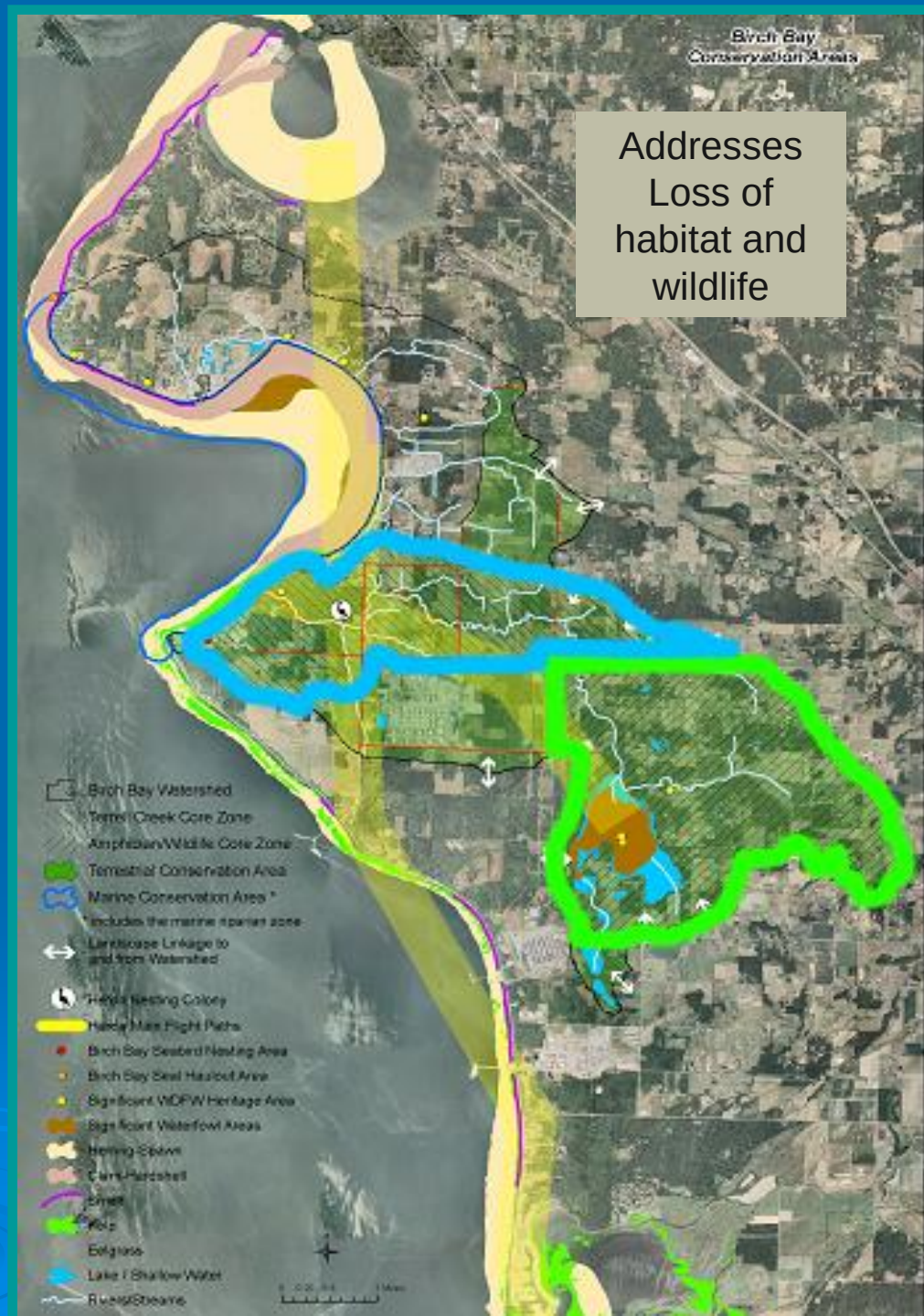
Synthesis: Identifying Solutions (Step 2)

- **Concentrate development** in "red" management units
- Allow use of **mitigation credits** in "yellow and green" zones for impacts in "red zone."
- **Cluster development** in "yellow and green" zones.
- Use **low impact development** measures
- Provide for **habitat protection** overlay



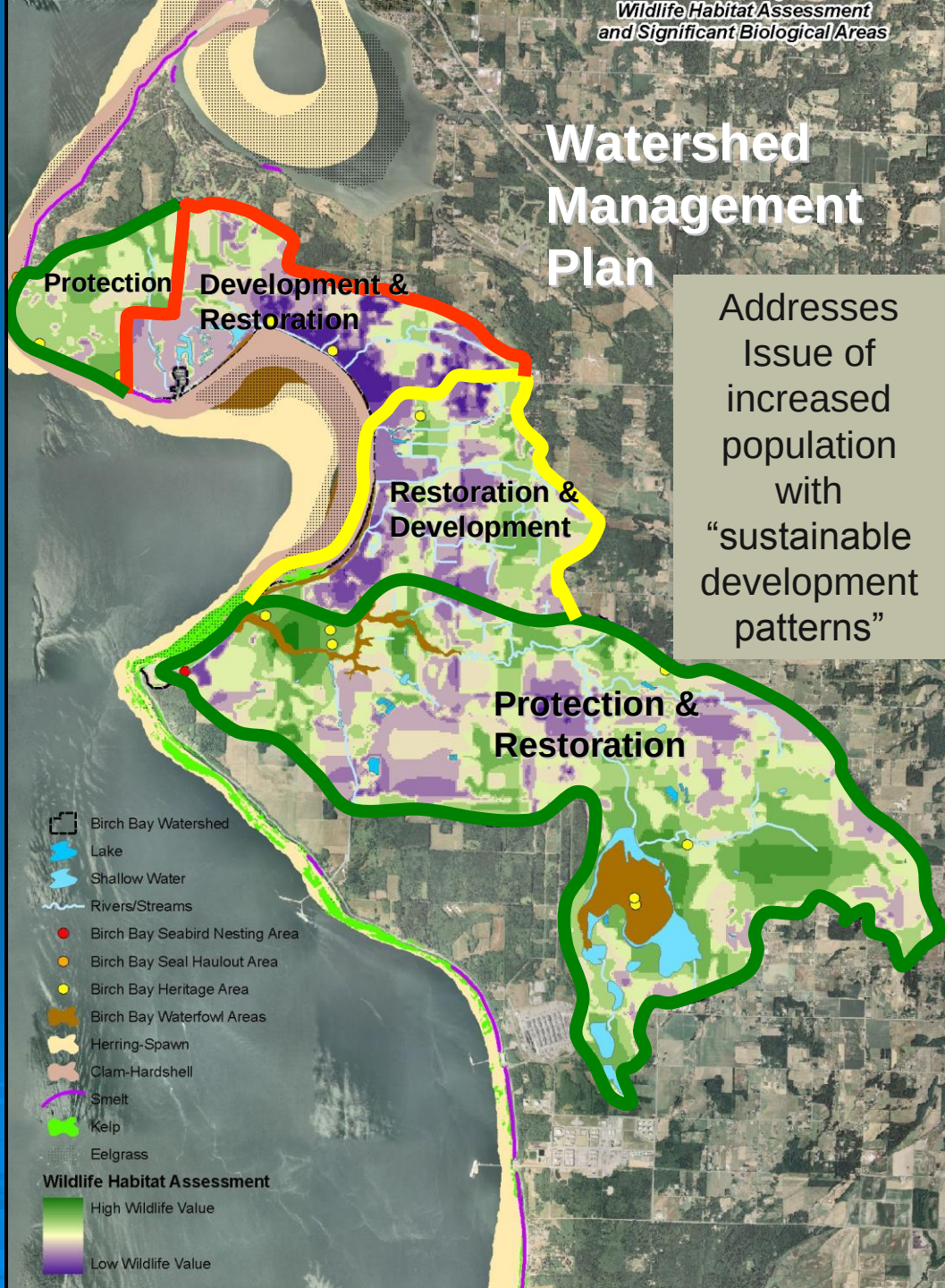
Synthesis of Results

- **Keep large areas** <= 1du/10 ac
- **Habitat Mosaic** - wetlands, open grassy areas, and connectivity areas, <= 1du/20ac
- **Minimize new roads**, traffic softening, signs for crossings
- **Connectivity** – greater than 80% native vegetation cover
- **Flyways** – maintain 0.5 mile wide, no tall buildings or towers, greater than 80% native vegetation cover

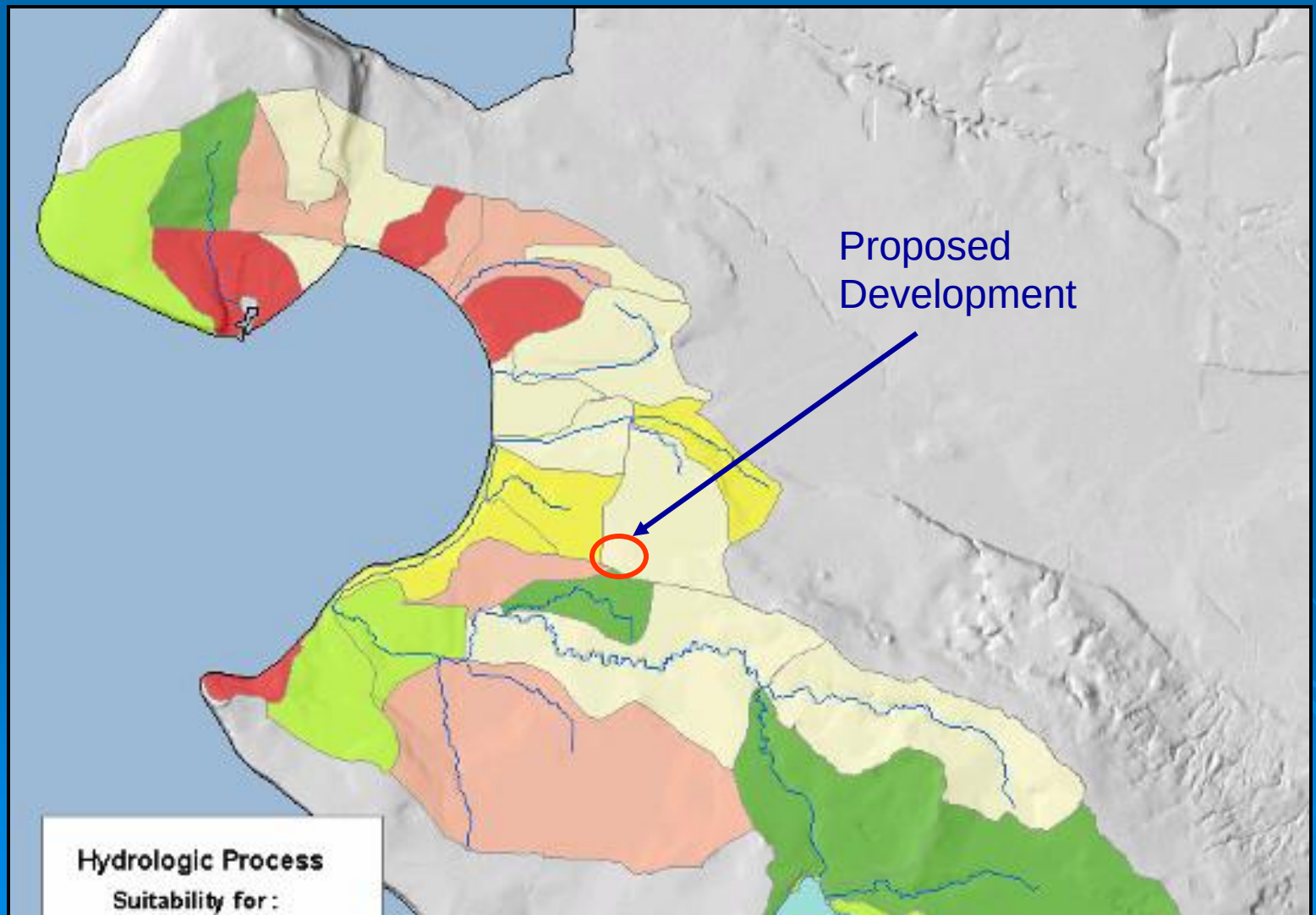


Synthesis: Identifying Solutions for Rural Properties

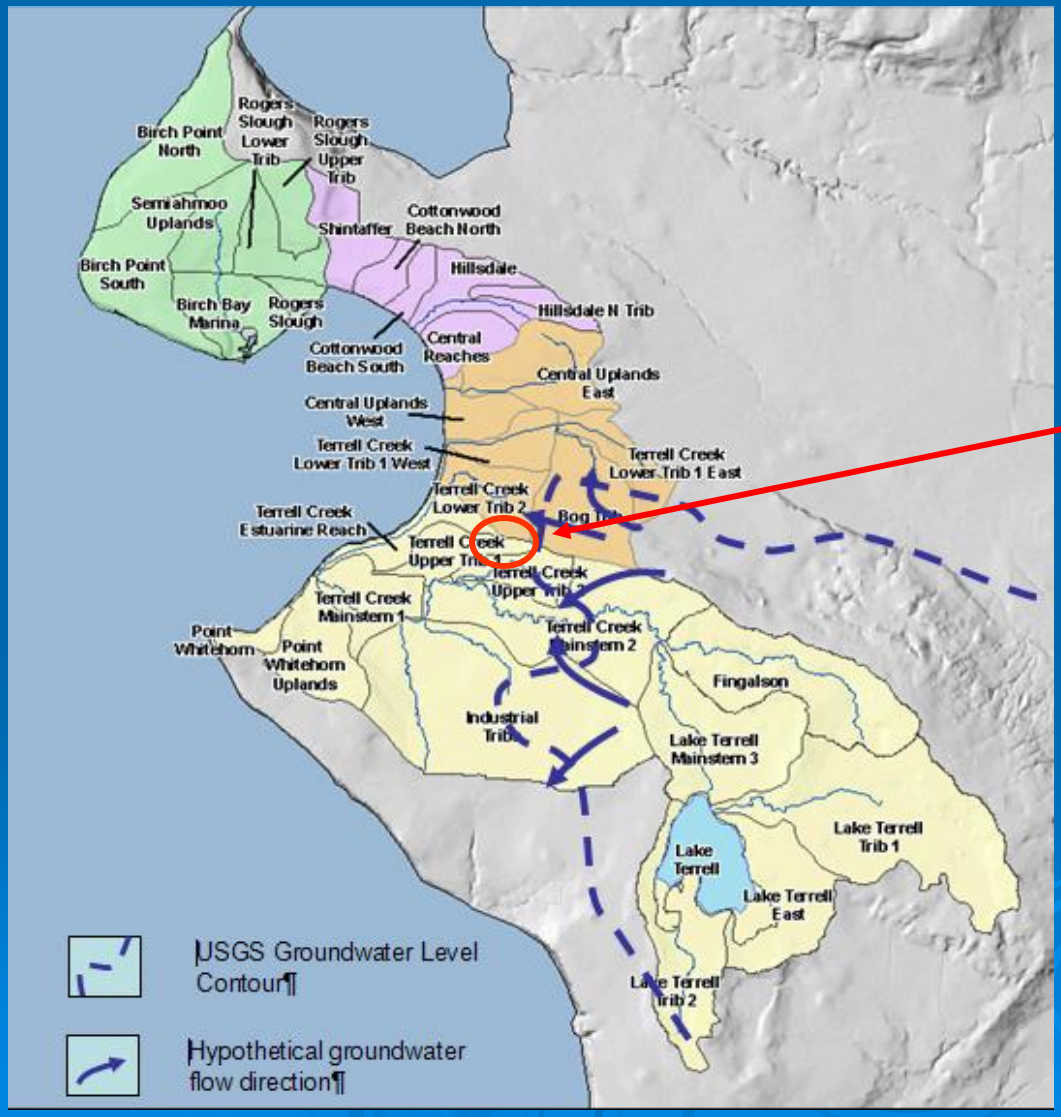
- **Special Development Fees** in "red" management units would be used to help farmers in green zone. Examples include:
  - Implementing Farm Plans in critical areas
  - Planting riparian buffer areas
  - Restoring degraded reaches of creeks
  - Purchasing conservation easements (similar to Wetland Reserve Program)
- Selling Credits to developers for wetlands created on rural properties



Applying Characterization Results at Fine Scale

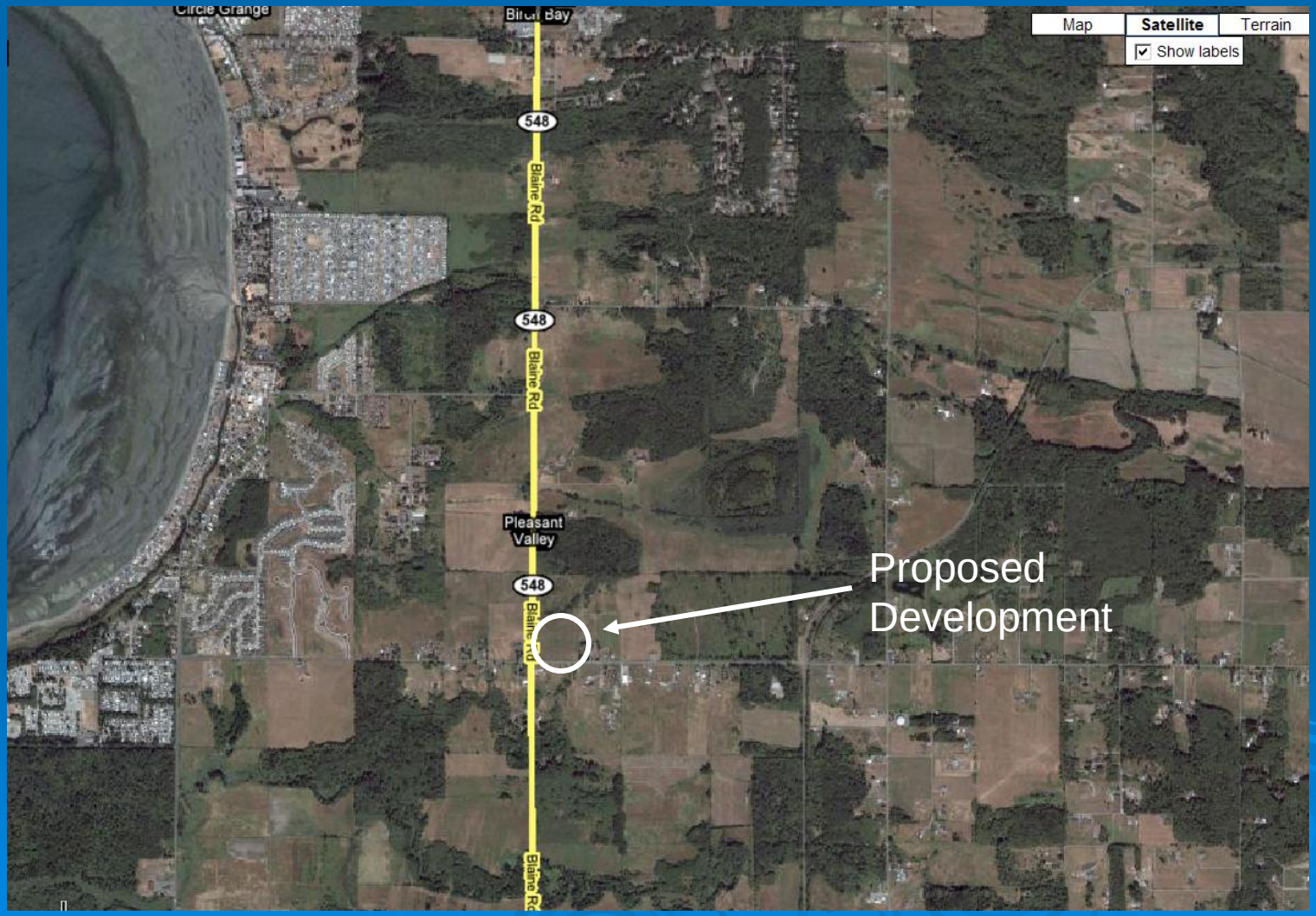


Water Flow Patterns

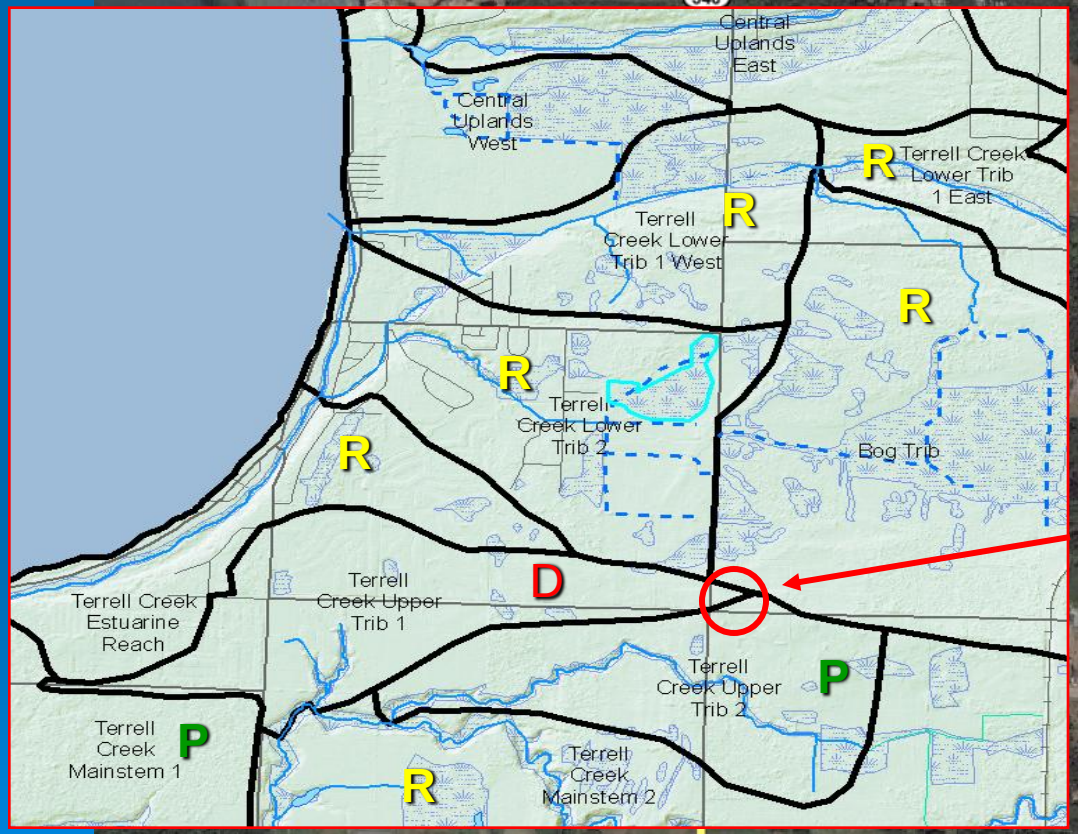


Proposed Development

Surrounding Uses



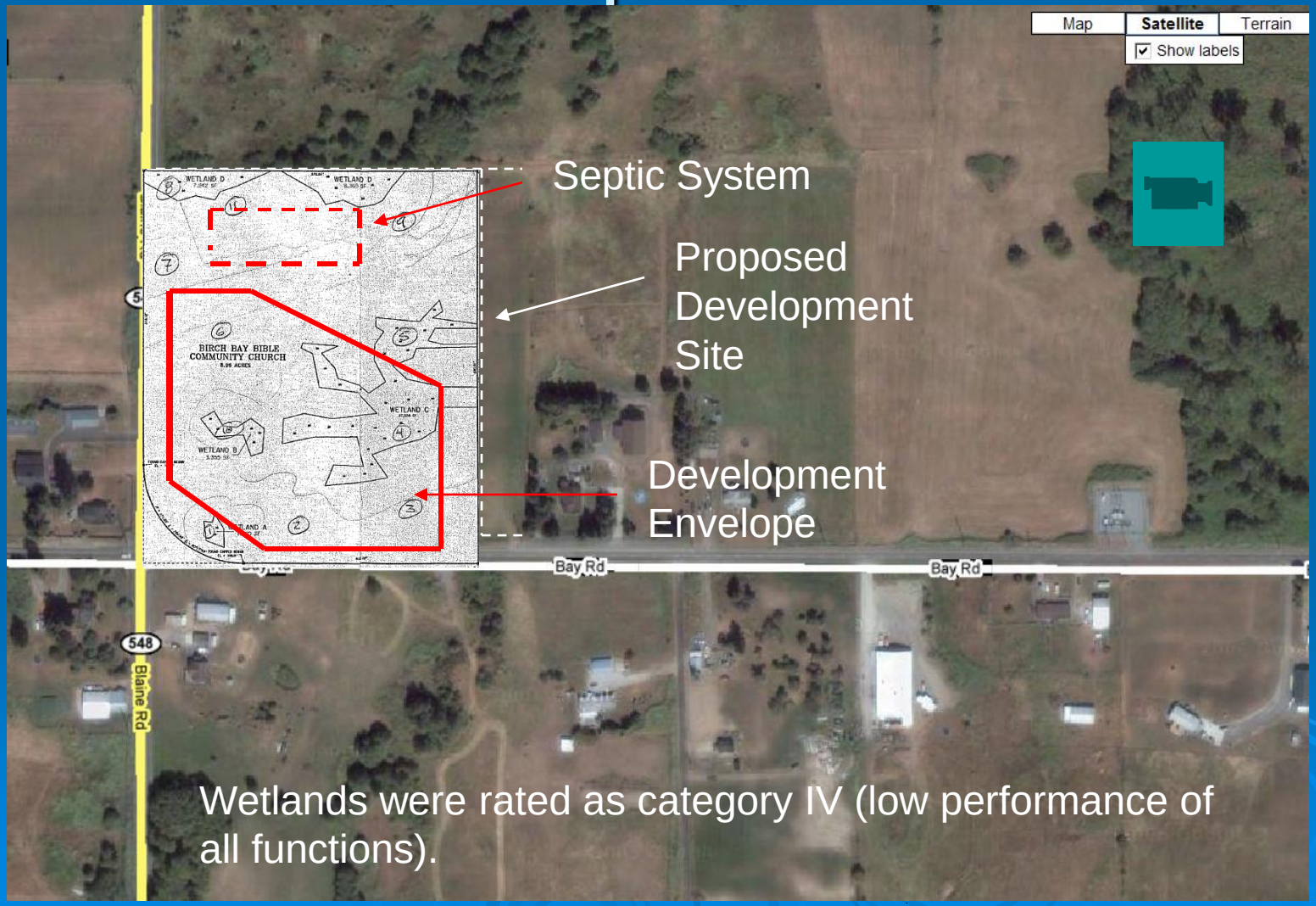
Wetlands Inventory & Characterization Results



Surrounding Uses

Surrounding Uses

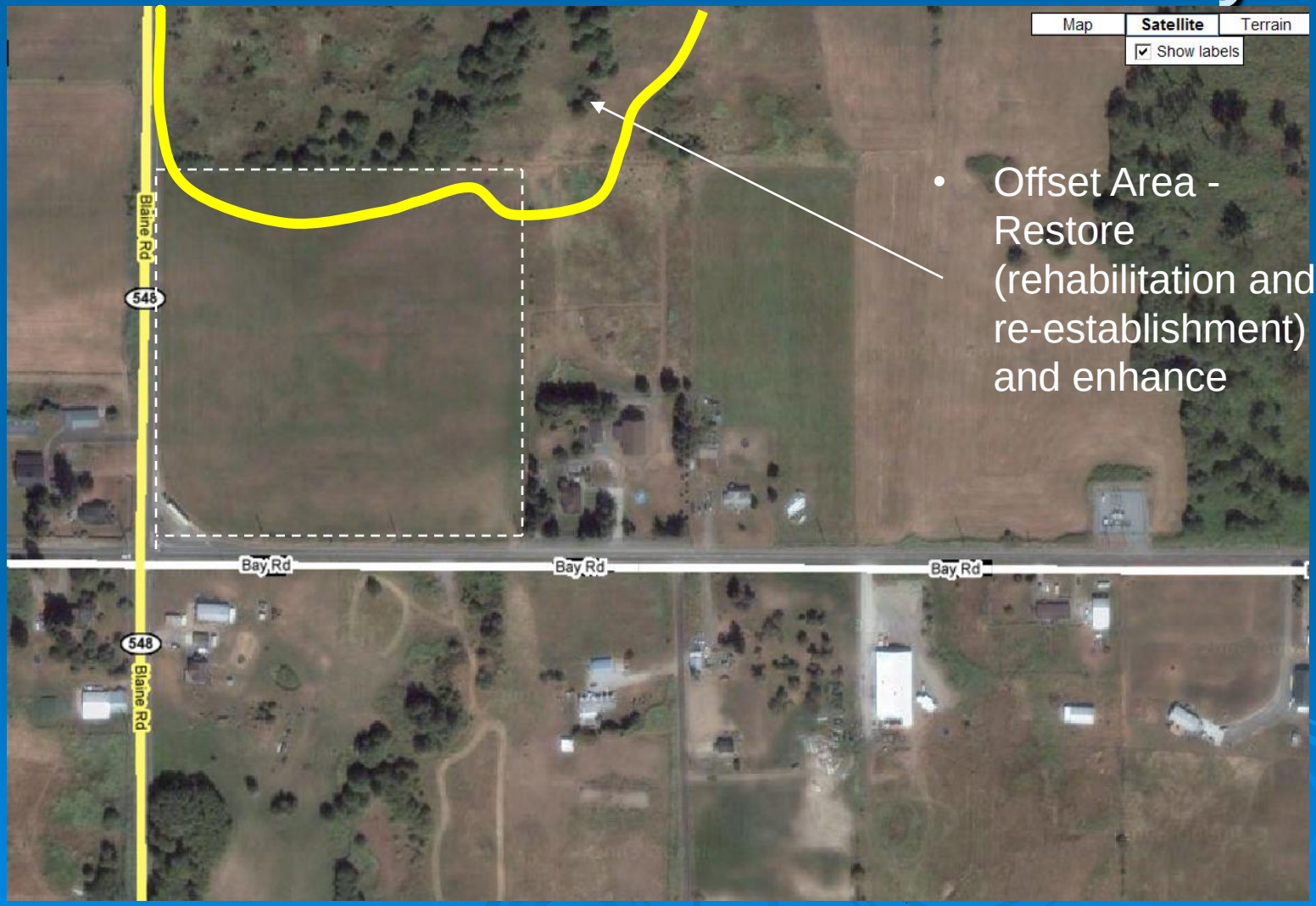
Site Conditions & Development Impacts



Synthesis Table

Reach or Site Name	Rating of Processes and Functions (unimpaired condtions)	Rating of Impairment (existing conditions)	Recommended Solutions
Bog Tributary	**Processes – Potential is high** for water flow process. Important area for groundwater discharge and surface storage *(Use characterization of important areas or existing info from basin plans for this rating)* **Functions – Potential is high for functions**. Historically a depressional wetland complex, including a large forested bog. High species richness for plant, amphibian, bird, fish and mammal species. *(For functions use existing information from Priority Habitat and Species program, Salmonscape , local wetland inventories, local wildlife experts and watershed plans. Use wetland rating system results if available)*	**Processess – Moderate to High**. The hydrology of the bog and adjoining wetlands has been affected by ditching and draining. This has reduced storage in the wetland complex, in turn affecting the flow regime in Terrell Creek. *(Use characterization of impairments for this rating or existing info from basin plans).* **Functions** - Extensive clearing of forest and scrub-shrub and emergent habitat has reduced species richness *(Ratings from the characterization of individual components such as forest clearing, wetland loss and stream floodplain loss can provide an indirect assessment of impairment to functions. Existing basin plan information, including proper functioning conditions analysis can also be used).*	**Land Use – Key area for restoration**. Measures to transfer develop rights (i.e. Transfer of Development Rights) and/or conservation easements in conjunction with clustering of development units should be used to protect and restore this depressional wetland complex. **Restoration measures.** Block or plug large ditches draining to the north and west of bog complex (see figure 22). Decommission smaller ditches in adjoining depression wetlands and replant with scrub-shrub and forested species.

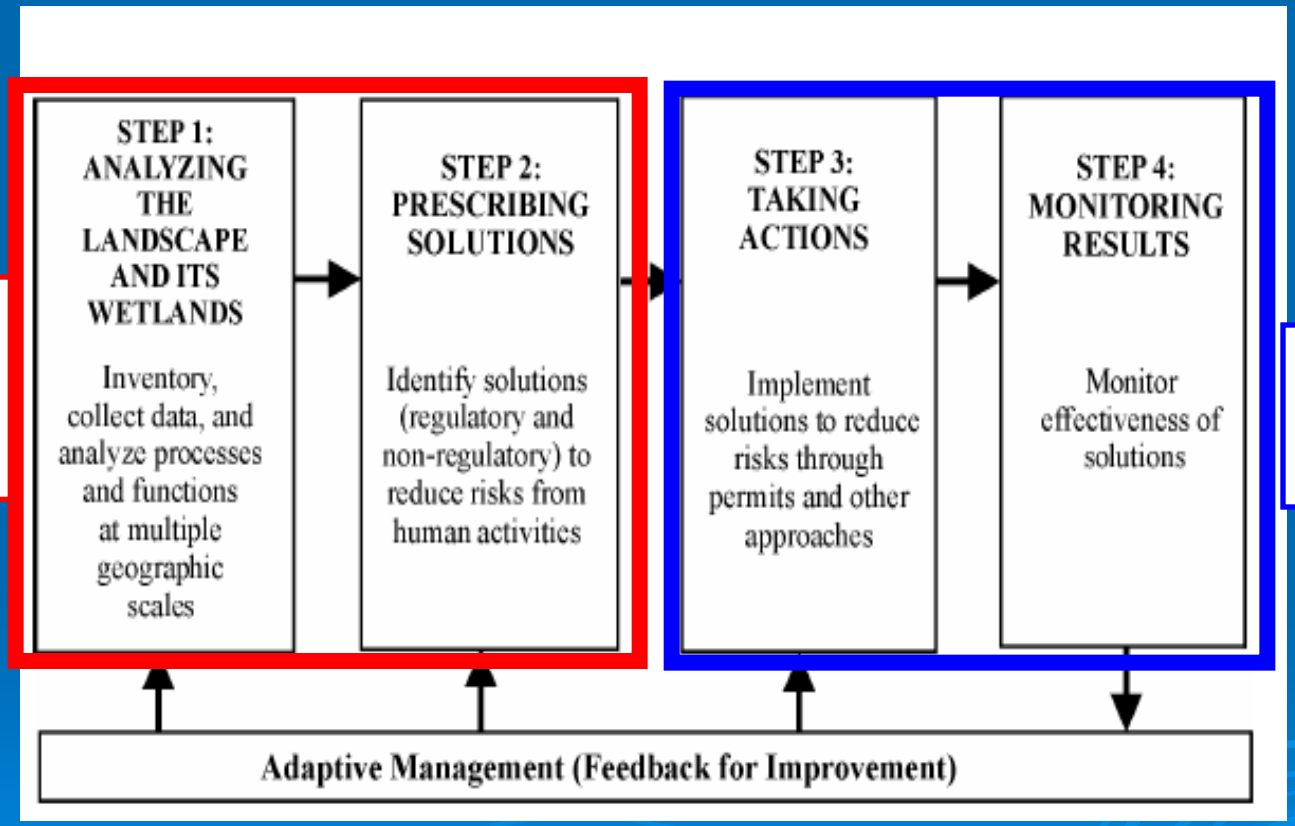
Recommended Mitigation Based on Watershed Conditions and Analysis



- Offset Area - Restore (rehabilitation and re-establishment) and enhance

Next Steps

Pilot Study (Analysis and Planning)



Future Implementation (if adopted)

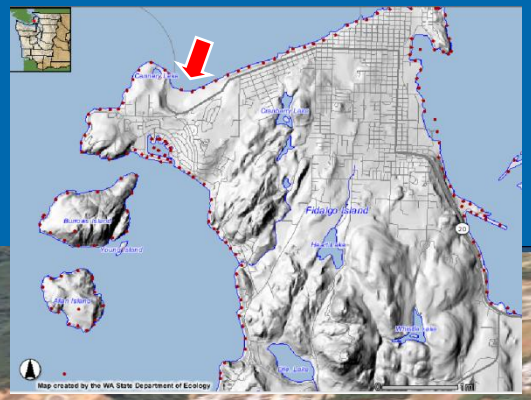
City of Anacortes

Using Existing Information and Synthesis Table to Characterize and Analyze Marine Shoreline

Ship Harbor: City of Anacortes SMP –Summary of Inventory/Characterization Analysis and SMP Designations and Regulations

Reach Name & Shoreline Designation	Potential Ecosystem process and associated shoreline function	Assessment of processes & functions	Level of Impairment to processes & functions	Protection & restoration measures
Ship Harbor Eastward on Guemes Channel – Urban and Residential Shoreline Designation Map with Proposed Changes West End - Shoreline Oblique Photo East End - Shoreline Oblique Photo	**Ecosystem process:** Water movement (tidal and wave energy); sediment movement (inputs, longshore transport, deposition and loss); shoreline erosion; and movement of woody debris; organic inputs from shoreline; **Shoreline functions:** Water quantity – discharge from streams/rivers and groundwater at shoreline Water quality - temperature regulation (i.e. marine riparian vegetation, groundwater discharge at shoreline, freshwater inputs from streams/rivers); nutrient removal (denitrification), sediment retention (e.g. deposition in estuaries and intertidal mudflats), toxicant removal & temperature regulation Habitat: shoreline, intertidal, estuarine, subtidal habitats. Habitat structure and complexity for marine plants, macroalgae, diatoms, marine invertebrates, fishes, birds, mammals and anadromous fish species and terrestrial plants and animls.	**Ecosystem processes :** Rating: Potential is high This shoreline is comprised of sandy material and is an open shoreline that experiences higher energy relative to other shorelines in the City. The sandy beach at the Ship Harbor wetland is a prograding beach. It appears that movement of sediment comes from the west at Shannon Point. East of Ship Harbor the shoreline is bordered by bluffs > 10 meters high that are comprised of unconsolidated materials. These bluffs represent a high potential for supplying sediment to adjacent beaches **Shoreline functions** Rating: Habitat functions are high. This is a forested marine shoreline. The intertidal zone includes patchy eelgrass, kelp, and macroalgae. In combination with the barrier wetland at Ship Harbor this shoreline, relative to other shoreline areas, has a high potential for habitat functions, including sand lance spawning habitat,(also see Salmonscape) Dungeness crab over wintering habitat and salmonid habitat. High for water quality and quantity functions. Probably an area of groundwater discharge, due to upland terrace (recharge area)	**Ecosystem processes:** Impairment Rating: Moderate to High. Shoreline armoring at the base of bluff has altered a number of the shoreline processes. Large shoreline structures are preventing the movement of bluff material into the shoreline environment **Functions at shoreline:** Impairment Rating: High Though majority of the shoreline bluff is vegetated, shoreline armoring at the base of the bluff for an old rail bed has removed shoreline vegetation which may affect adjacent juvenile salmonid habitat Impacts on shoreline sediment processes may restrict extent of sand lance spawning habitat east of Ship Harbor. Majority of shoreline provides juvenile salmon habitat and has a moderate restoration potential. Derelict pilings and slag metal from old cannery present in Ship Harbor wetland.	**Ecosystem processes and functions:** This is a key restoration area (sediment processes from adjoining bluffs) and "in-lieu fees from other areas (e.g. Burrows Bay) will be used to help protect and restore sediment processes and biological functions. Includes removing pilings and slag from Ship Harbor wetland (Restoration #34) and creating an interpretive center and observation boardwalk and overlook. City policy calls for installation of a public access path along the top of the existing railroad bed. Restoration measures include "capping" of the shoreline armoring of this rail bed and planting with native vegetation. This will improve some of the biological functions for this shoreline. The City will attempt to restore bluff erosion processes along portions of trail that are presently experiencing slides (by re-routing trail to beach). Vertical access ways will be considered where trail is not continuous. **Consistency of Environment Designation** with assessment of processes and functions and degree of Impairment. Residential 3 designation provides for a 150 buffer for the Ship Harbor Wetland. Conservancy Designation for Ship Harbor Wetland provides long term protection given high habitat value (forested and emergent barrier marsh with adjoining habitat for sand lance, Dungeness crab). Residential 3 designation requires a 150 foot buffer and setback from the OHWM, which will protect bluff vegetation and erosion processes.

Ship Harbor Wetland



Conservancy Designation for Ship Harbor Wetland

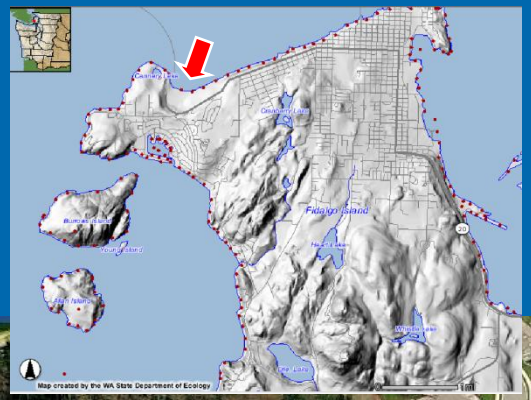
Sand Lance Spawning Habitat. Over wintering habitat for Dungeness Crab

Shoreline Residential 3 – 150' setback & buffer from OHWM

Urban

Longshore Drift

Ship Harbor Wetland



Conservancy Designation
for Ship Harbor Wetland

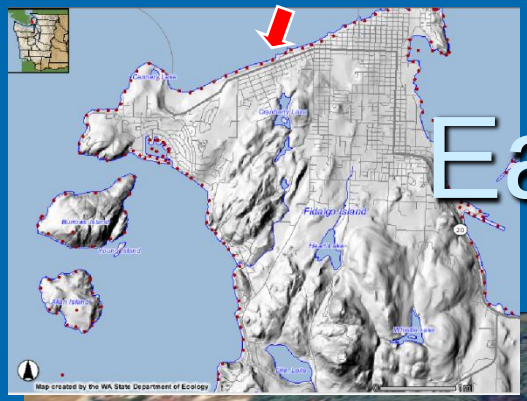
Prograding Beach –

Sand Lance Habitat

Restoration # 34 – includes removing pilings, slag in wetland and installing wetland interpretive center, walkways, public access from ferry terminal

Longshore Drift

East of Ship Harbor

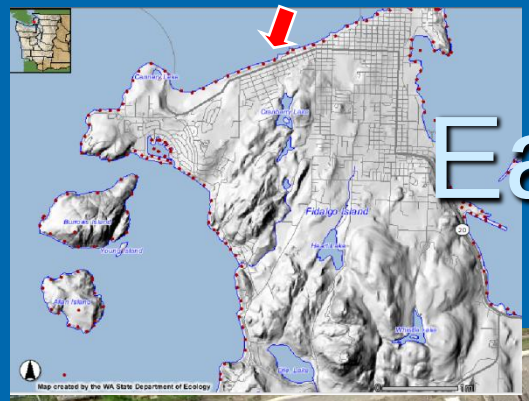


Heavily armored shoreline – sediment processes altered

Shoreline Residential 3

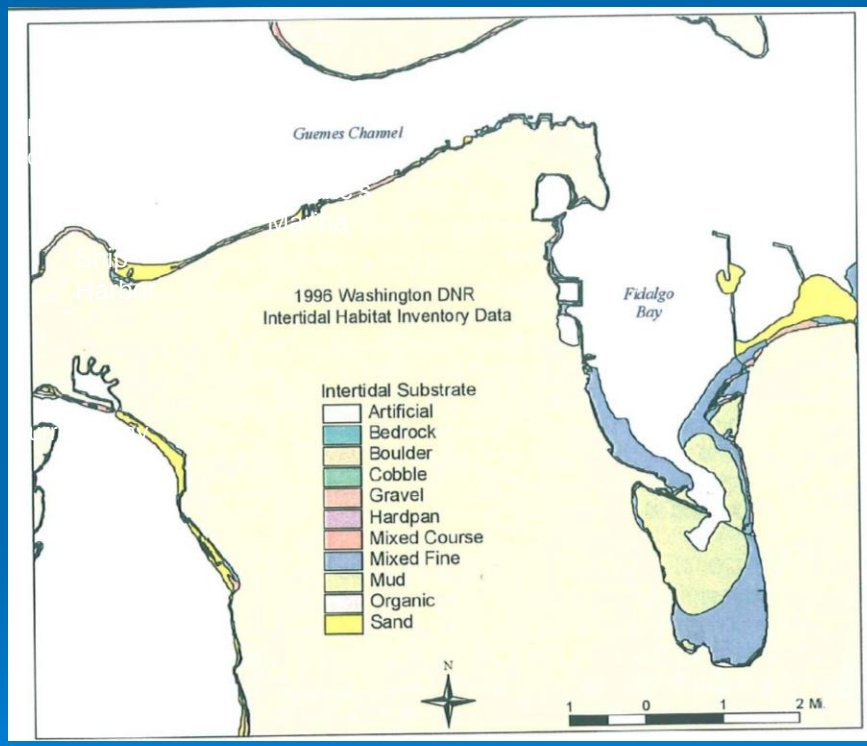
Biological functions high – kelp, patchy eelgrass, salmon habitat.

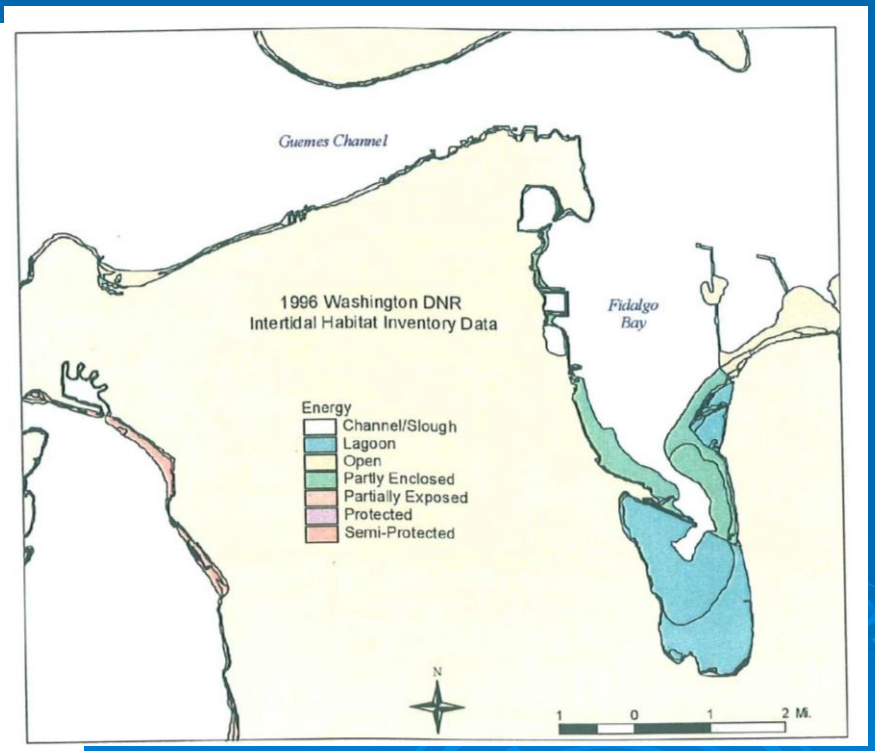
East of Ship Harbor



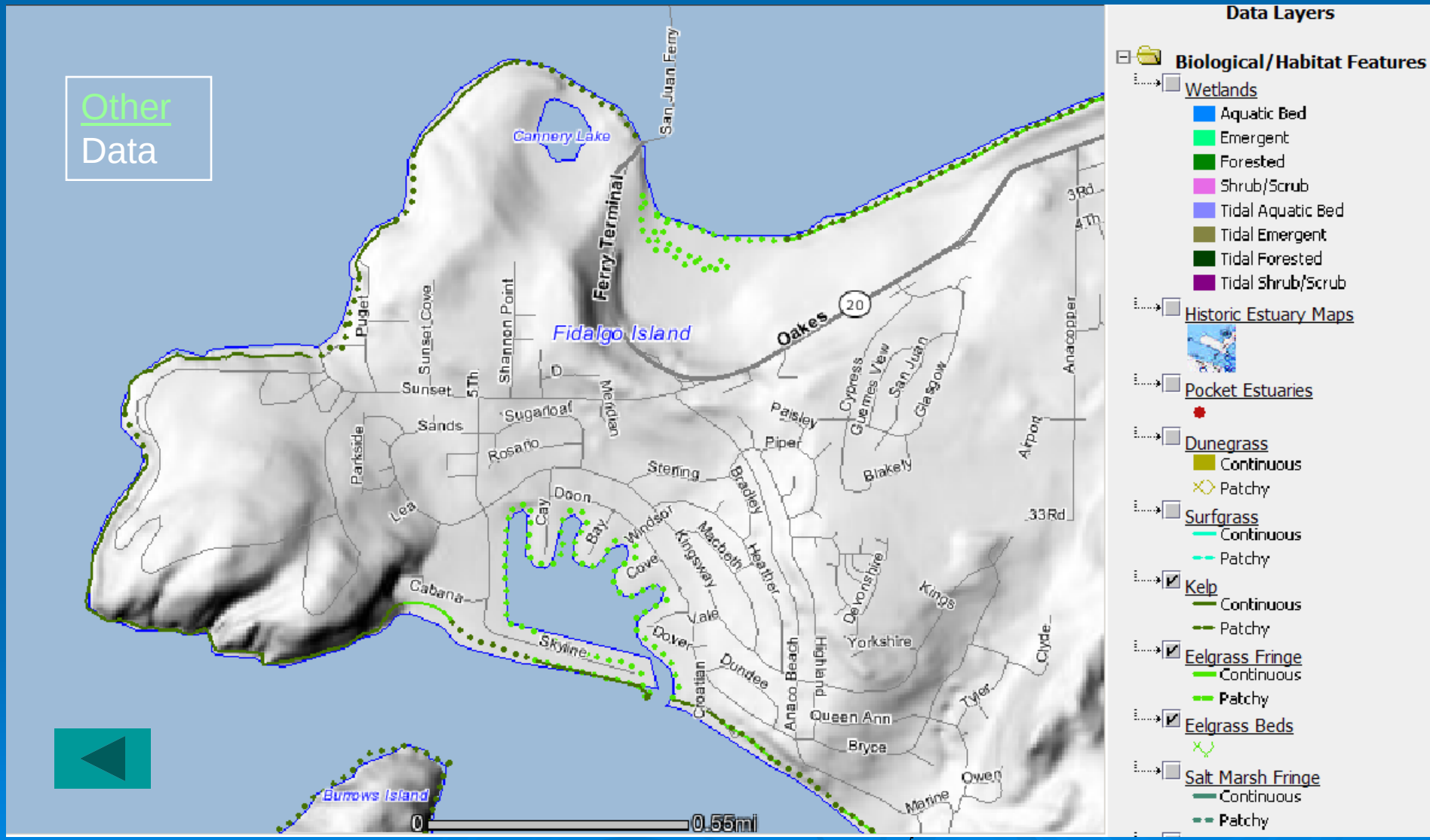
High Restoration Potential

Shoreline Processes

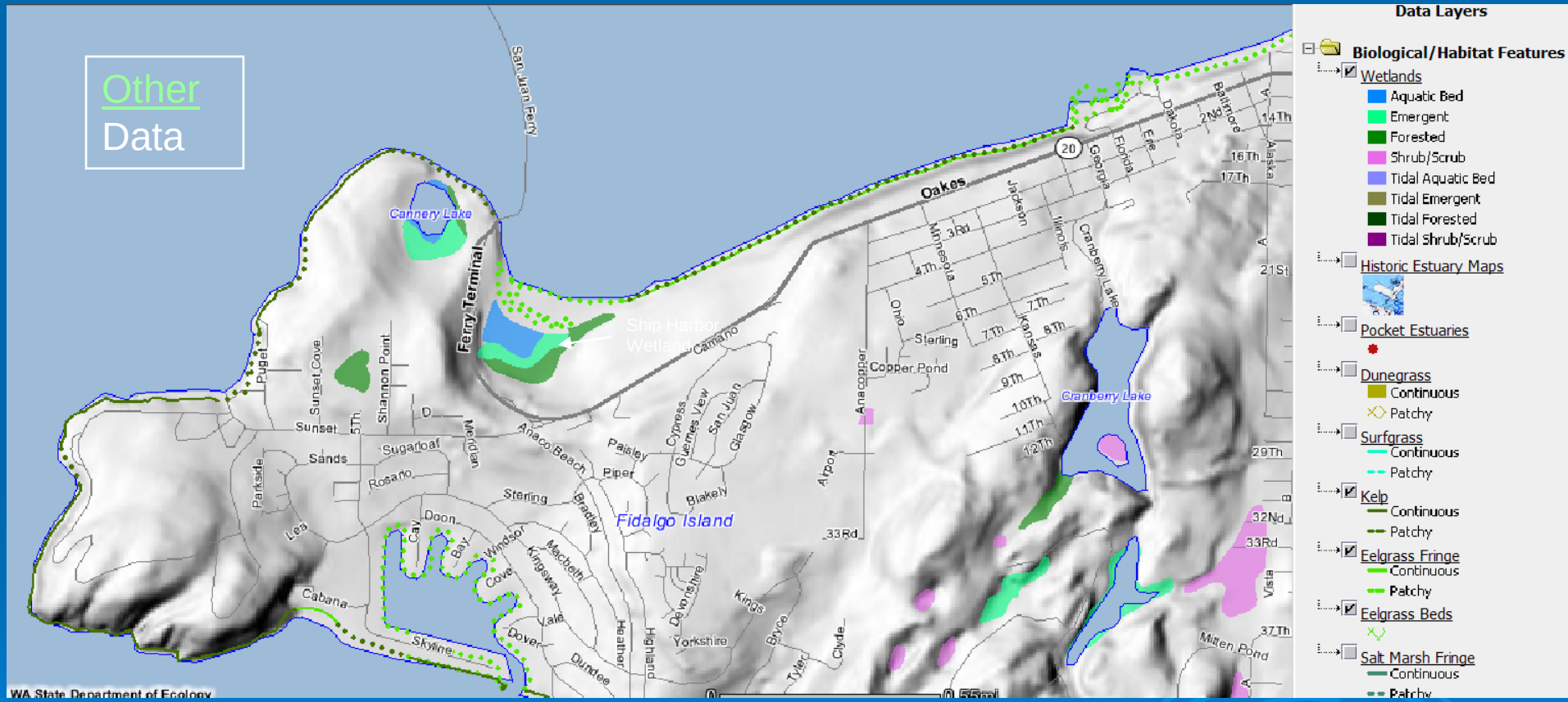




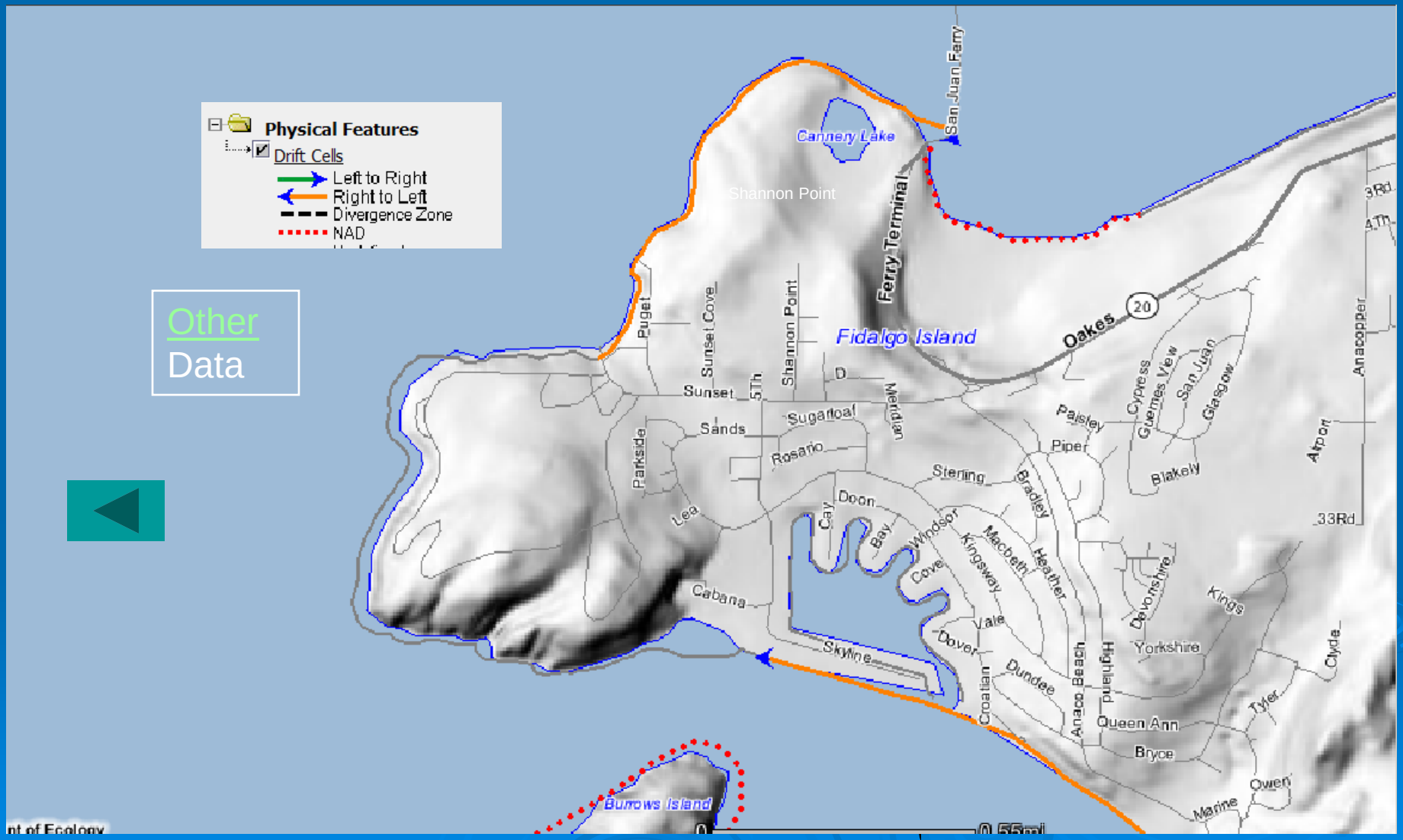
Coastal Atlas - Processes & functions



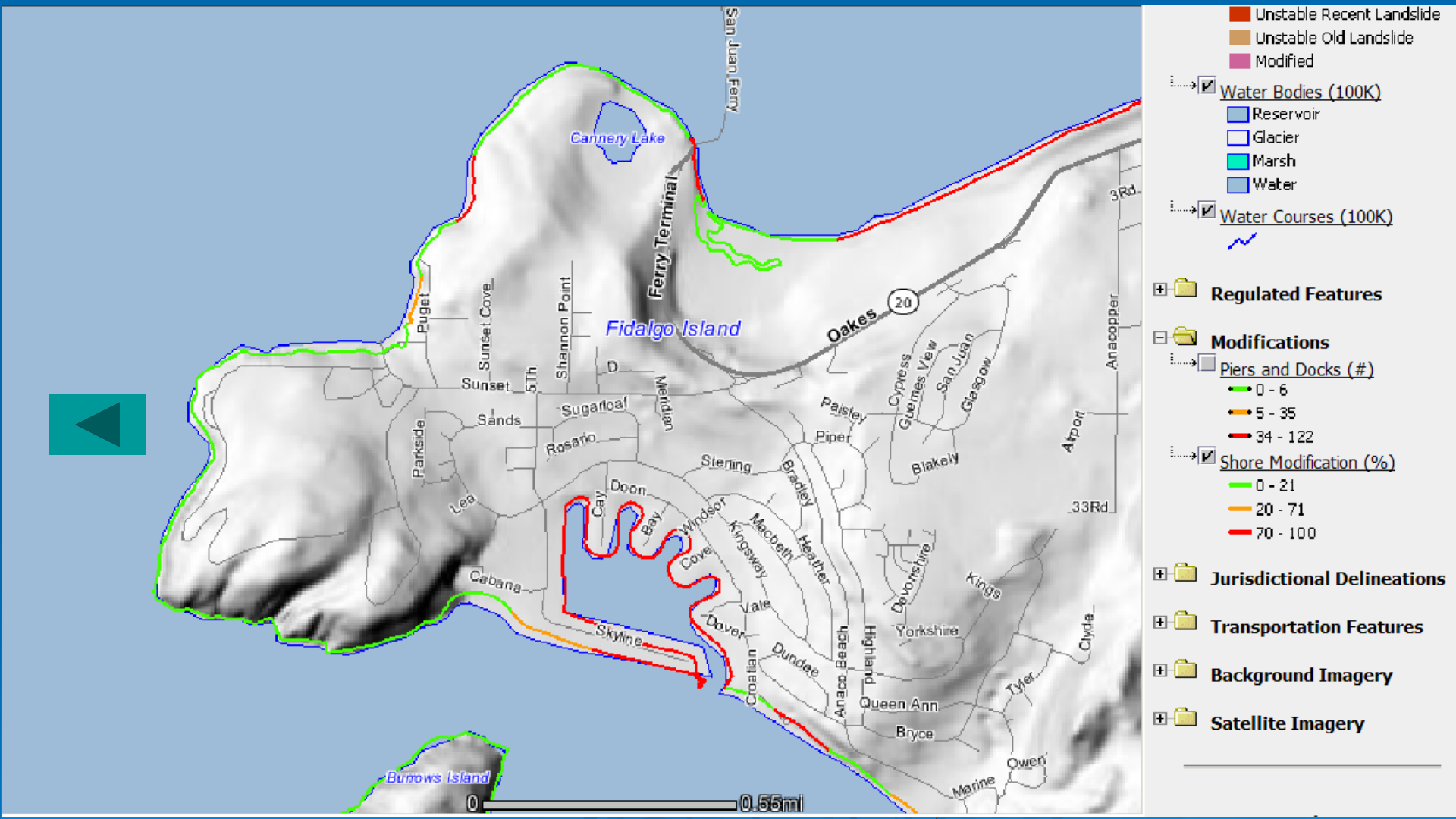
Coastal Atlas - Processes & functions

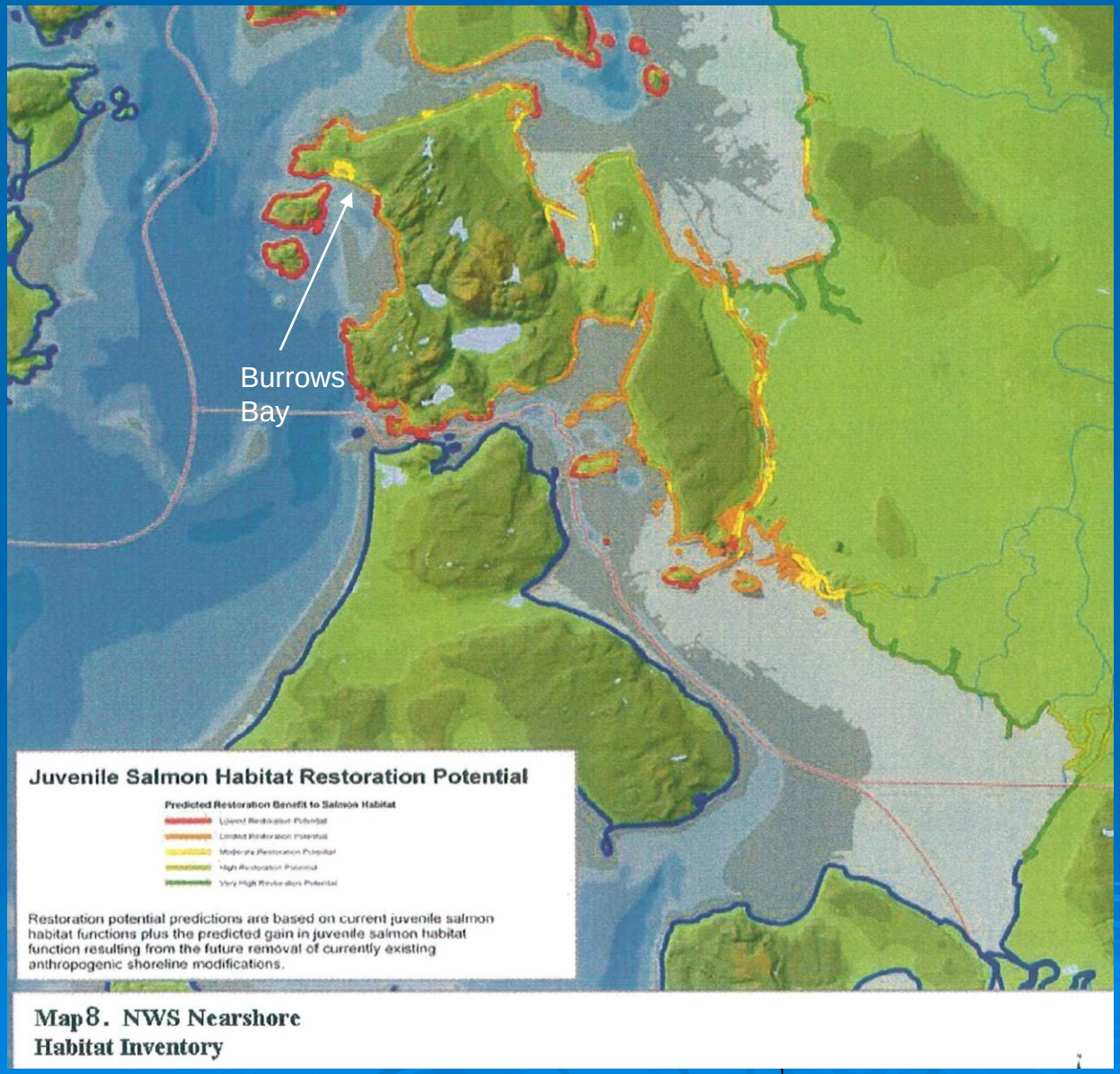


Coastal Atlas - Processes & functions



Coastal Atlas - Processes & functions





Map 8. NWS Nearshore Habitat Inventory

Environmental

Reach: Shannon Pt. & Fidalgo Head

Designation: Natural/Conservancy

Reach: Lovric's Marina

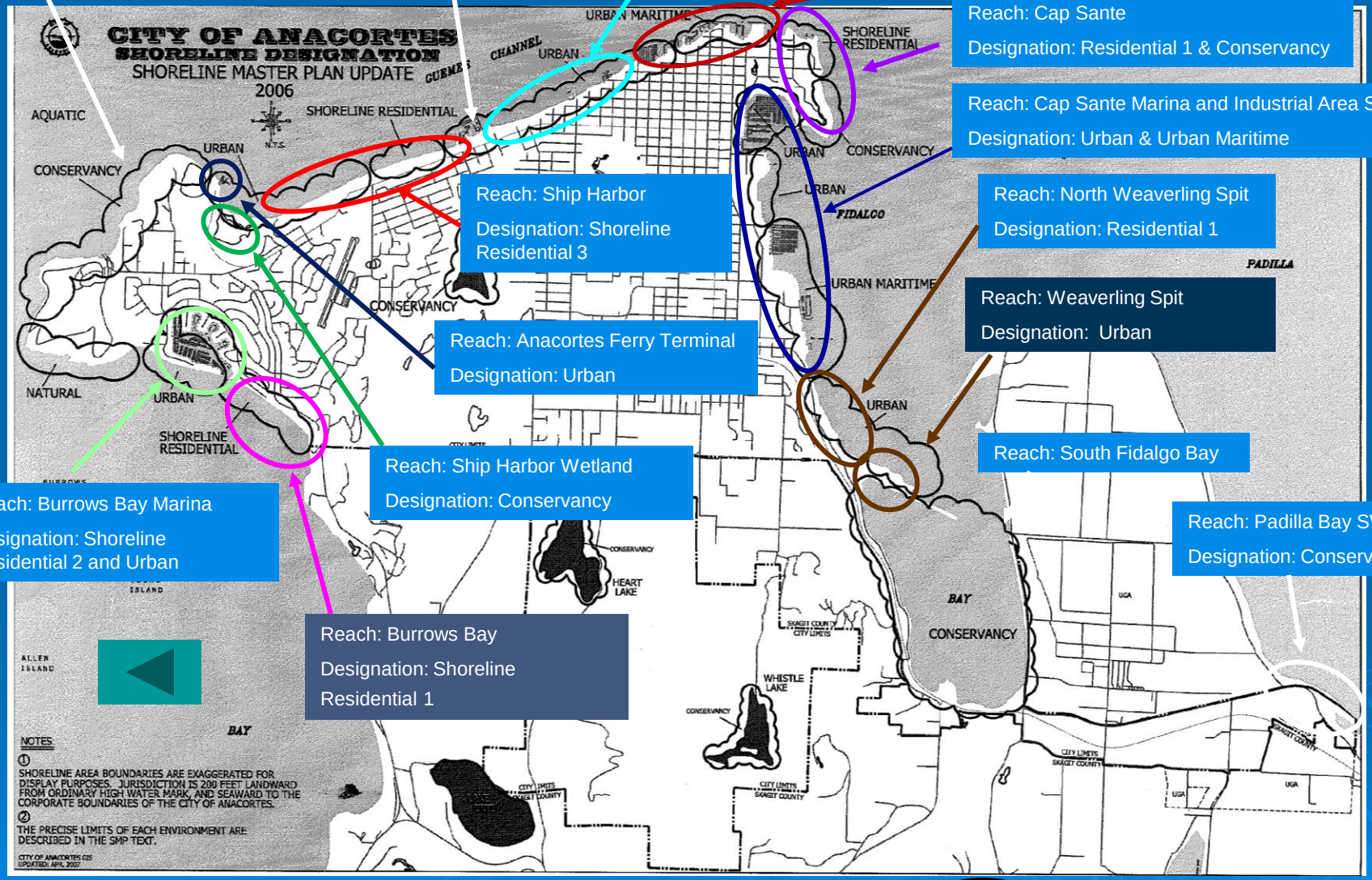
Designation: Urban

Reach: East of Lovric's Marina

Designation: Shoreline Residential 1

Reach: Cap Sante North

Designation: Urban Maritime Expanded



Reach: Cap Sante

Designation: Residential 1 & Conservancy

Reach: Cap Sante Marina and Industrial Area South

Designation: Urban & Urban Maritime

Reach: Ship Harbor

Designation: Shoreline Residential 3

Reach: North Weaverling Spit

Designation: Residential 1

Reach: Weaverling Spit

Designation: Urban

Reach: Anacortes Ferry Terminal

Designation: Urban

Reach: South Fidalgo Bay

Reach: Ship Harbor Wetland

Designation: Conservancy

Reach: Burrows Bay Marina

Designation: Shoreline Residential 2 and Urban

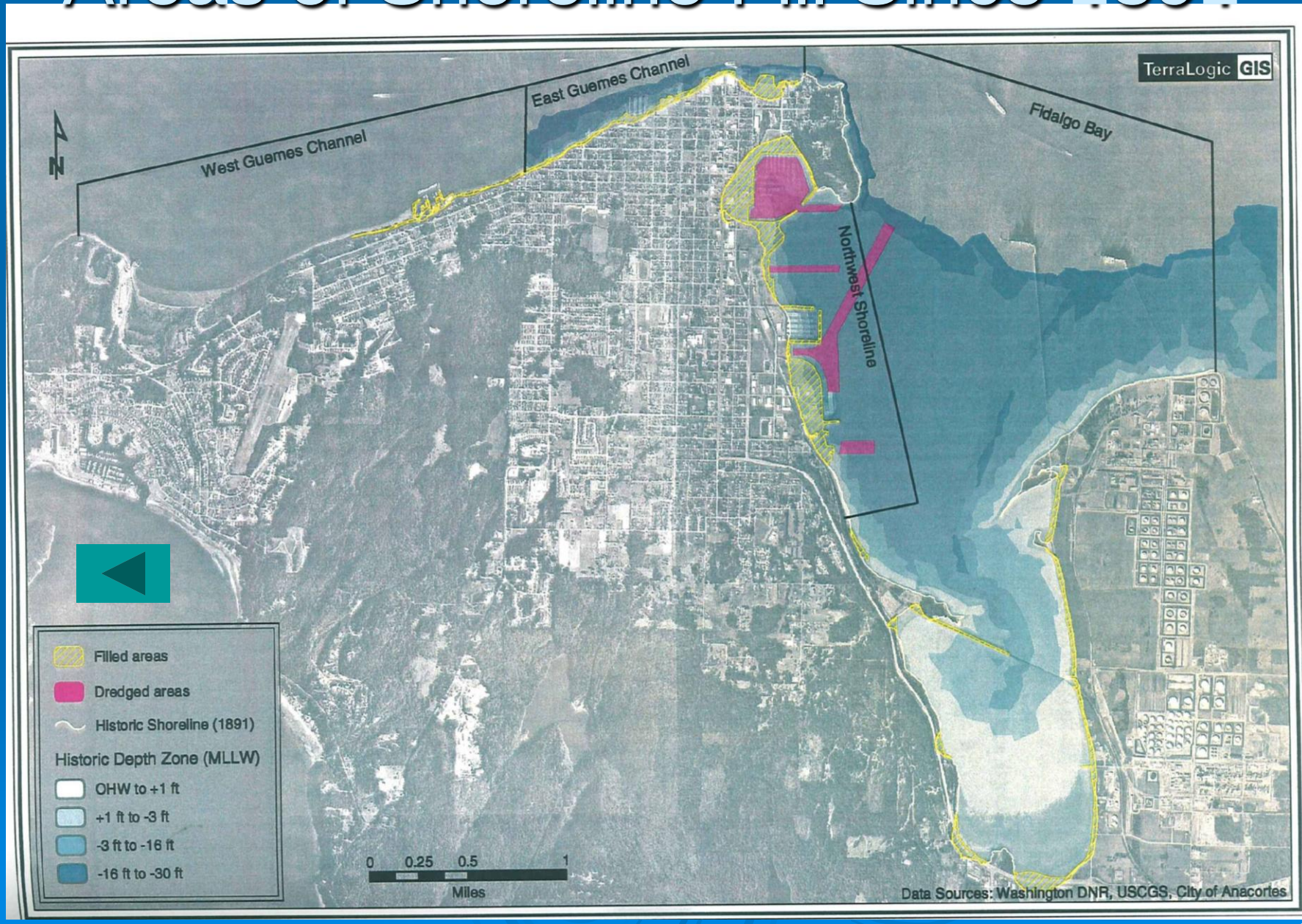
Reach: Padilla Bay SW

Designation: Conservancy

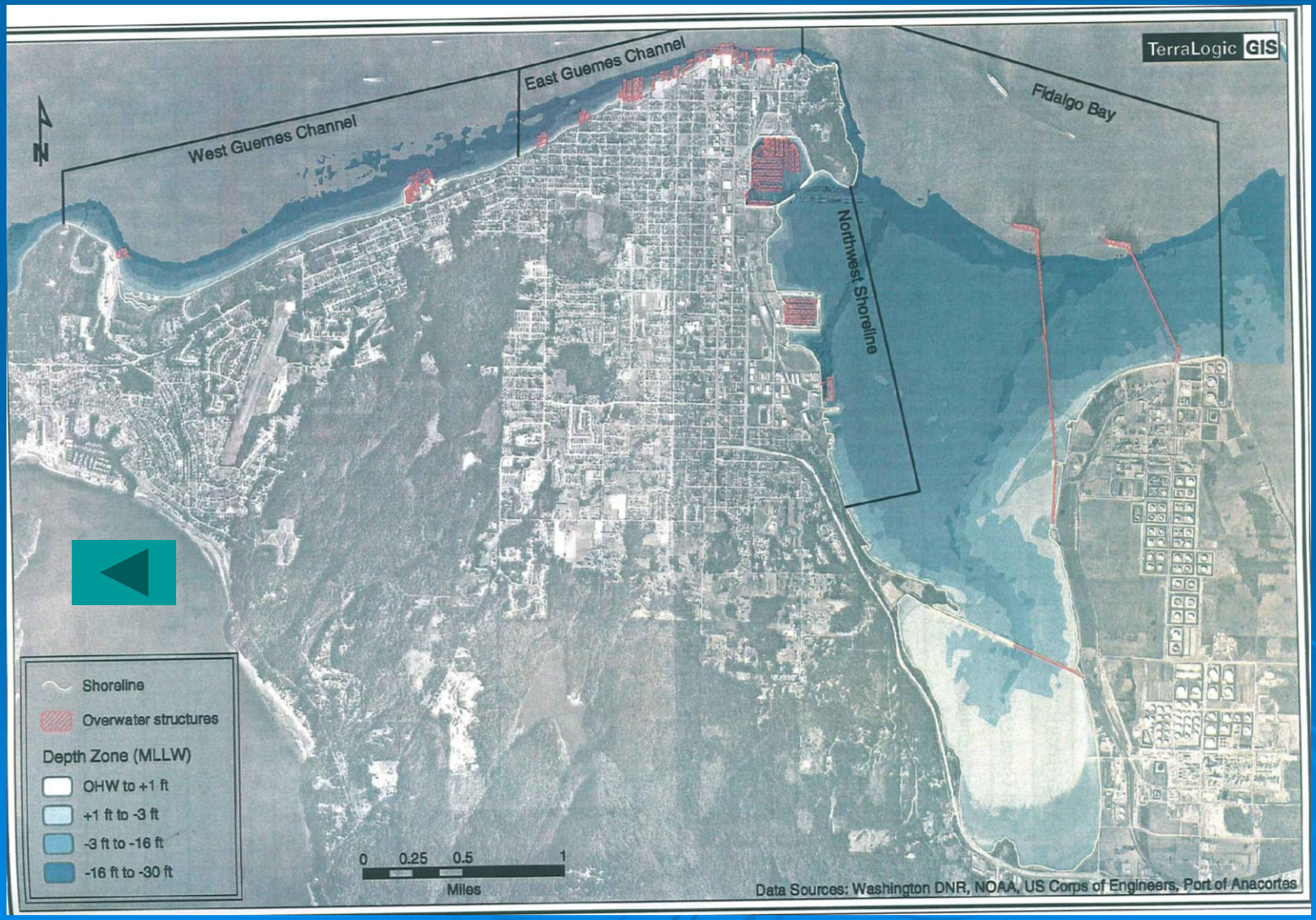
Reach: Burrows Bay

Designation: Shoreline Residential 1

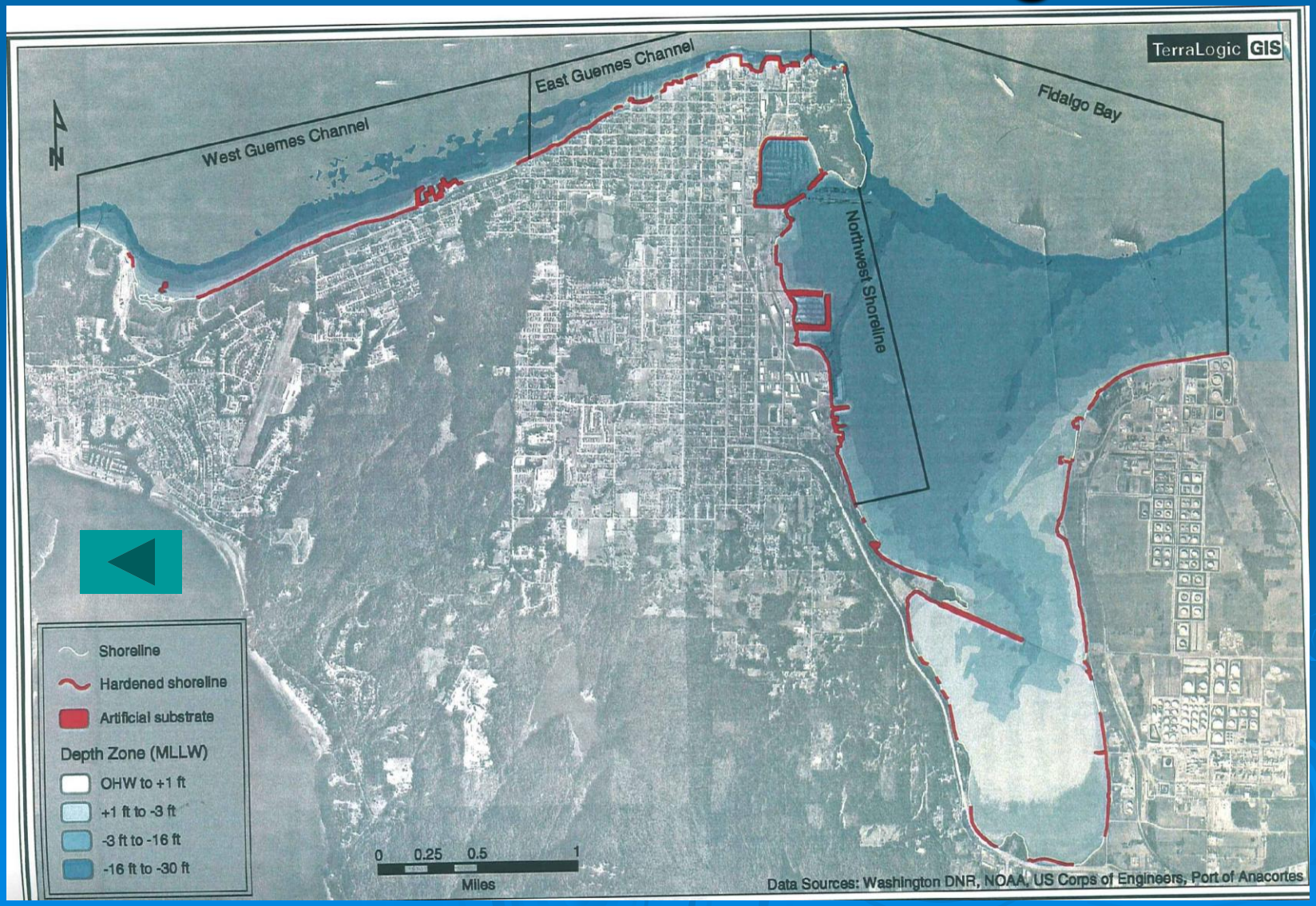
Areas of Shoreline Fill Since 1891



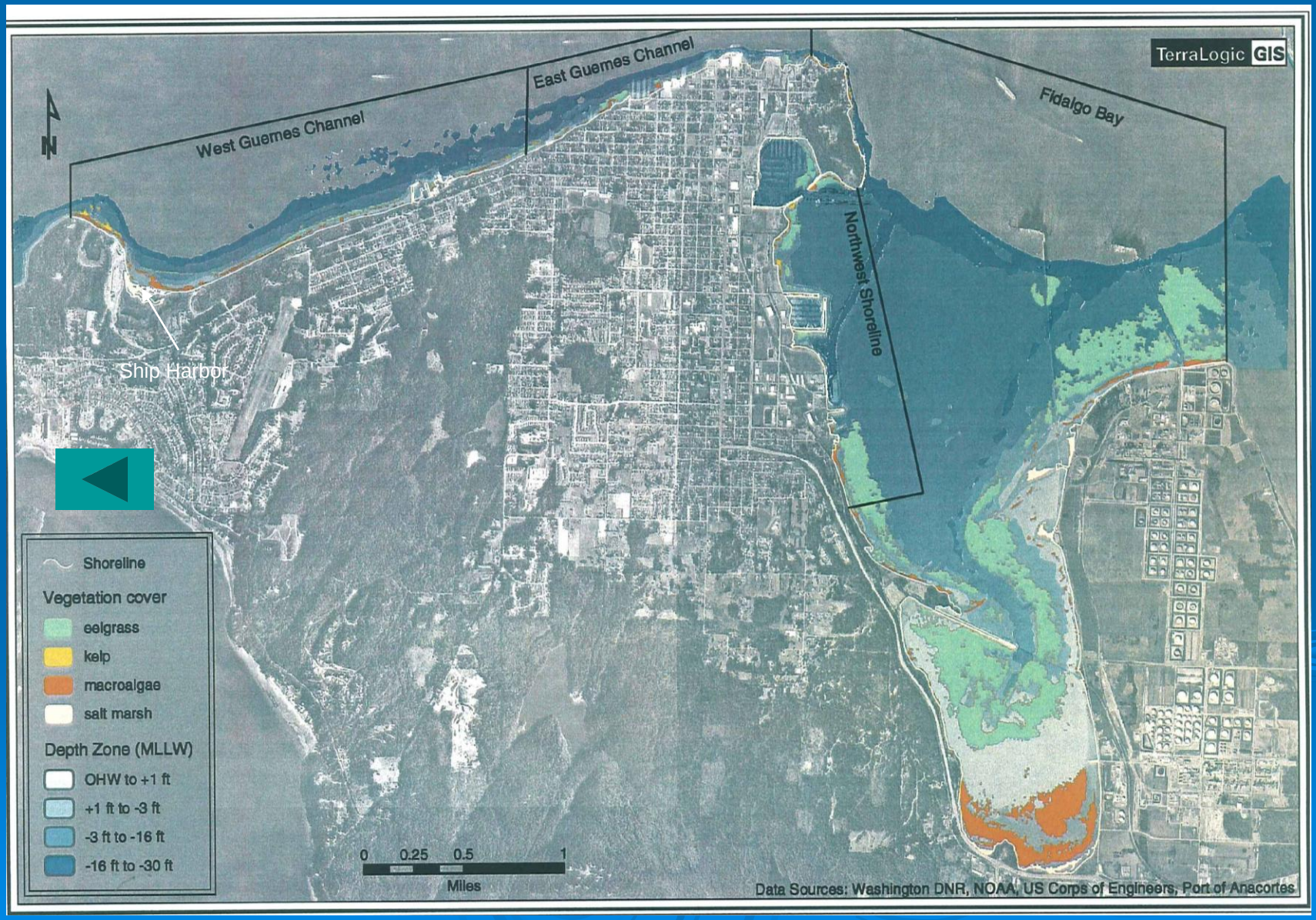
Overwater Structures



Shoreline Armoring



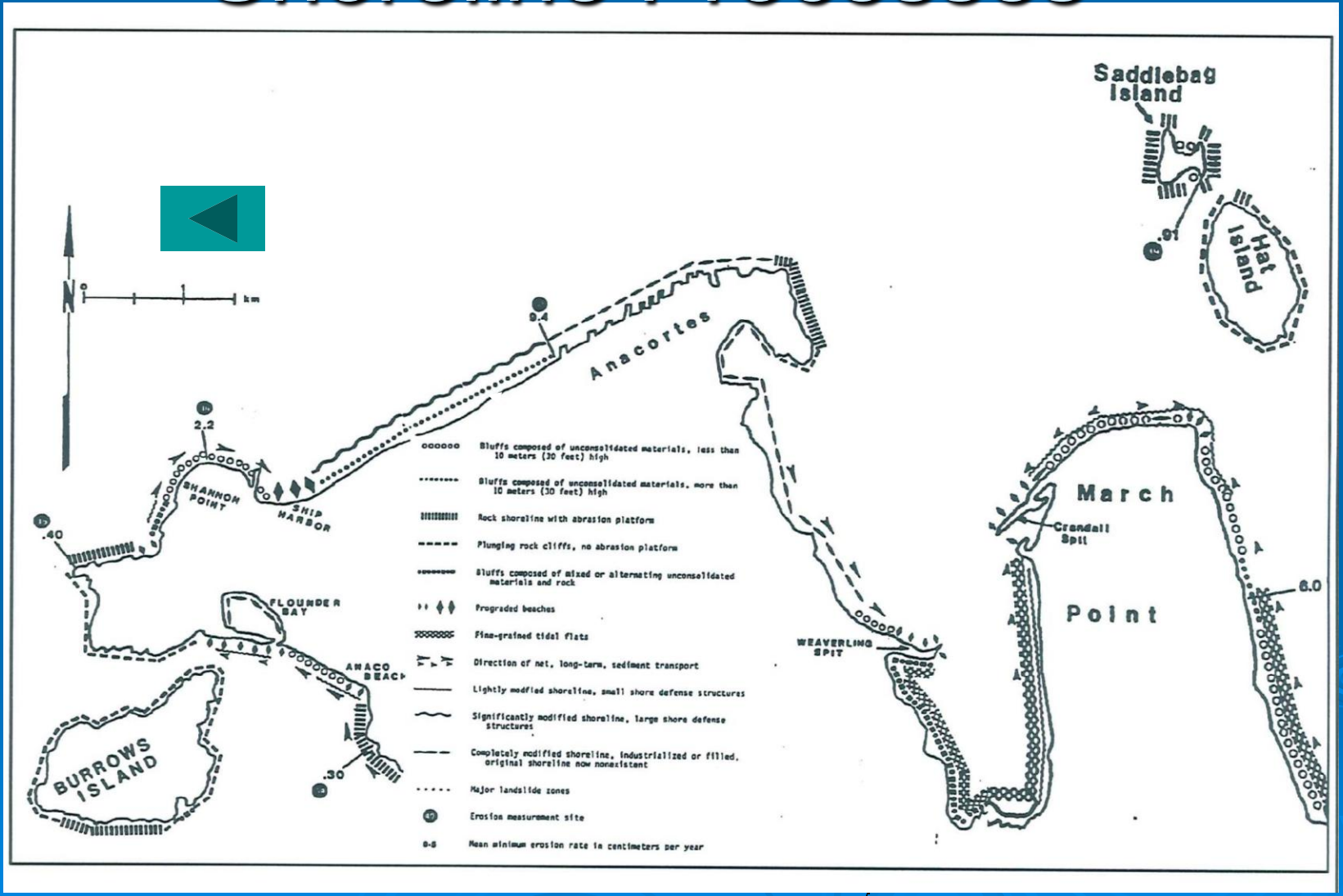
Marine Vegetation



Surf Smelt & Sand Lance Spawning

Forage Fish Spawning Habitat

Shoreline Processes



Source: Revised Final Integrated Fidalgo Bay-Wide Plan and EIS

Summary & Wrap-up

//www.ecy.wa.gov/programs/sea/wetlands

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Air Land Water Toxics Waste

Wetlands

Ecology Home > Sho

Wetland Mitigation
- Wetland Mitigation Home (coming soon!)
- Wetland Mitigation Banking
- Wetland Mitigation Guidance
- "Mitigation that Works" Stakeholder Forum
- Wetland Mitigation Evaluation Study

Wetland Regulation
- Environmental Permitting Services
- GMA and Local Wetland Regulations
- Isolated Wetlands
- Prior Converted Croplands

Wetland Stewardship

Wetland Tools
- Wetland Delineation
- Wetland Rating Systems
- Best Available Science
- Understanding Watershed Processes
- Function Assessment Project

Training & Education

Other Links
- Wetland Publications
- Frequently Asked Questions (coming soon!)
- Wetland Contacts
- Wetland Listserv
- How to Hire a Qualified Wetland Professional

Wetlands: Natu... Water Filters

Look around. More lik... you live, work, or play... acres in Washington St... land. Wetlands are cri... Because of their key r... Ecology is charged with... state's remaining wetla...

Wetland functions ir... people, including:

- Flood control
- Ground water re...
- Water filtration ...
- Erosion control
- Wildlife habitat
- Recreation
- Research and e...
- Regional econor...

The functions that an i... location, surrounding t... duration of water, and ... wetland may not perfo... wetlands in a watershe...

To learn more about w... (coming soon!).

Ecology's Role i... Managing Wetla...

Two state laws, the Sta... Shoreline Management...

//www.ecy.wa.gov/mitigation/landscapeplan.html

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Air Land Water Toxics Waste

Mitigation That Works

MITIGATION HOME
- Permitting Process
- Guidance and Regulations
- Landscape Planning
- Mitigation Options
- Training

- Mitigation News
- Resources & Publications
- Glossary
- Contacts

Mitigation home > Landscape Planning

Landscape Planning

Land use planning and permit decisions are usually not adequately informed by an understanding of ecosystem processes or watershed conditions. We believe one of the keys to making mitigation work is to move away from the narrow and often confrontational view of site-by-site piecemeal solutions, and towards a broader ecosystem or watershed scale view to achieve a more functional and resilient natural system. Landscape planning is a suggested approach for incorporating this understanding into the local government planning and permitting process.

Purposes
- Sustain and restore aquatic resources.
- Establish a common approach to coordinate planning efforts.
- Involve the community in developing a green infrastructure plan.
- Promote the integration of the Growth Management Act (GMA) and Shoreline Management Act (SMA).
- Assist in preparation of...
  - Establishing a fra... restoration plan
  - Promoting "no n...

Benefits
- Provides for the compre... maintenance of quality
- Guides future developm...
  - Identify and avo... community to co...
  - Provide backgro... plan updates, inc...
  - Reduce total dev...
- Streamlines permitting
  - Provide a predic...
  - Reduce permit r...
  - Provide more loc...
- Provides flexibility to meet the needs of the community.

Watershed Characterization

In its most basic form, watershed characterization information can help identify areas that are:

- priorities for acquisition (or protection via conservation easements),

Contact:

Stephen Stanley ssta461@ecy.wa.gov

Susan Grigsby sgri461@ecy.wa.gov

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